### First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-2001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>W. Uhlig, J. E. E. Buschmann, S. Canonica, P. Funck, E. C. Meister, R. Verel</td>
</tr>
<tr>
<td>401-0251-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6 credits</td>
<td>4V+2U</td>
<td>A. Cannas da Silva</td>
</tr>
<tr>
<td>551-0001-00L</td>
<td>General Biology I</td>
<td>O</td>
<td>3 credits</td>
<td>3V</td>
<td>U. Sauer, O. Y. Martin, A. Widmer</td>
</tr>
</tbody>
</table>

**Abstract**

529-2001-02L: General Chemistry I: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium.

401-0251-00L: This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.

551-0001-00L: Organismic biology to teach the basic principles of classical and molecular genetics, evolutionary biology and phylogeny.

**Objective**

529-2001-02L: Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

401-0251-00L: Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

551-0001-00L: The understanding of some basic principles of biology (inheritance, evolution and phylogeny) and an overview of the diversity of life.

**Content**

529-2001-02L: 1. Stoichiometry

2. Atoms and Elements (Quantenmechanical Model of the Atom)

3. Chemical Bonding

4. Thermodynamics

5. Chemical Kinetics

6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)

401-0251-00L: 1. Single-Variable Calculus:

2. Linear Algebra and Complex Numbers: systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.

3. Ordinary Differential Equations: separable, exact, and homogeneous ordinary differential equations (ODEs), integration by substitution, first order ODEs, homogeneous systems of linear ODEs with constant coefficients, second order ODEs.

551-0001-00L: First in a series of two lectures given over two semesters for students of agricultural and food sciences, as well as of environmental sciences.
The first semester focuses on the organismal biology aspects of genetics, evolution and diversity of life in the Campbell chapters 12-34. The lecture discusses the role of the environmental systems based on selected environmental problems, among these the exploration of Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; Environmental Systems I

Slides are provided by instructors and are accessible via moodle.

The students are able to explain important properties of the three environmental systems, to discuss critical drivers, trends and conflicts of O

The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the individual, the population, the community and the ecosystem level.

The students should learn ecological concepts at these different levels in the context of concrete examples from terrestrial and aquatic ecology. Corresponding methods for studying the systems will be presented.

A further aim of the lecture is that students achieve an understanding of biodiversity, why it is threatened and how it can be managed. O

- Übersicht der aquatischen und terrestrischen Lebensräume mit ihren Bewohnern
- Einfluss von Umweltfaktoren (Temperatur, Strahlung, Wasser, Nährstoffe etc.) auf Organismen; Anpassung an bestimmte Umweltbedingungen
- Populationsdynamik: Ursachen, Beschreibung, Vorhersage und Regulation
- Interaktionen zwischen Arten (Konkurrenz, Koexistenz, Prädation, Parasitismus, Nahrungsnetze)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Ökosysteme: Kompartimente, Stoff- und Energieflüsse
- Biodiversität: Variation, Ursachen, Gefährdung und Erhaltung
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution

Content

- Underlagen, Vorlesungssfolien und relevante Literatur sind in der Lehrdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagmorgen zur Verfügung.

Lecture notes

Unterlagen, Vorlesungssfolien und relevante Literatur sind in der Lehrdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagmorgen zur Verfügung.

Biology III: Essentials of Ecology

701-0243-01L

Biology: III Essentials of Ecology

O 3 credits 2V S. Güsewell, C. Vorburger

Abstract

This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in ecological research. Ecological concepts are exemplified by using aquatic and terrestrial systems; corresponding methodological approaches are demonstrated. In a more applied part of the lecture threats to biodiversity and the appropriate management are discussed.

Objective

The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the individual, the population, the community and the ecosystem level.

The students should learn ecological concepts at these different levels in the context of concrete examples from terrestrial and aquatic ecology. Corresponding methods for studying the systems will be presented.

A further aim of the lecture is that students achieve an understanding of biodiversity, why it is threatened and how it can be managed.

Content

- Ausblick auf die aquatischen und terrestrischen Lebensräume mit ihren Bewohnern
- Einfluss von Umweltfaktoren (Temperatur, Strahlung, Wasser, Nährstoffe etc.) auf Organismen; Anpassung an bestimmte Umweltbedingungen
- Populationsdynamik: Ursachen, Beschreibung, Vorhersage und Regulation
- Interaktionen zwischen Arten (Konkurrenz, Koexistenz, Prädation, Parasitismus, Nahrungsnetze)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Ökosysteme: Kompartimente, Stoff- und Energieflusse
- Biodiversität: Variation, Ursachen, Gefährdung und Erhaltung
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution

Lecture notes

Unterlagen, Vorlesungssfolien und relevante Literatur sind in der Lehrdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagmorgen zur Verfügung.

Aquatisc Ökologie:

Lampert & Sommer 1999. Limnökologie. Thieme. 2. Aufl., ca. Fr. 55.-;
Bohle 1995. Limnische Systeme. Springer, ca. Fr. 50.-

Naturschutzbiologie:

Course Content

- Awareness of the link between plant anatomy, systematics, physiology, ecology, and development.

Course Literature


Course Prerequisites

- Groups of a maximum of 30 students.

Course Objective

- This practical course provides an introduction to elementary laboratory techniques. The experiments cover a wide range of techniques, including analytical and synthetic techniques (e.g. investigation of soil and water samples or the preparation of simple compounds). Furthermore, the handling of gaseous substances is practised.
- The classification and analysis of natural and artificial compounds is a key subject of this course. It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks: Selected samples (e.g. soil and water) will be analysed with various methods, such as titrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvatation or precipitation processes) is studied.

Course Summary

This course shall particularly elucidate the cross section of Agro- and Food Sciences in the context of important global problems to be solved. Furthermore the students in the first year of studies shall be given some insight and outlook supporting the development of their views and interests in agricultural and food sciences further.

The course is part of the block exam after the first study year. Paper copies can be used ("Open Book") during the on-line exam, but no other means are not allowed. The course is taught in German.

Additional First Year Courses

- Biology I: Laboratory Exercises
- Laboratory Course: Elementary Chemical Techniques
- Informatics
Lecture notes
All materials for the lecture are available at www.evim.ethz.ch
Prerequisites / notice
This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

Bachelor Studies (Programme Regulations 2010)
3. Semester
Basic Courses II: Examination Block 1

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0063-00L</td>
<td>Physics II</td>
<td>O</td>
<td>5</td>
<td>3V+1U</td>
<td>A. Vaterlaus</td>
</tr>
</tbody>
</table>

Abstract
Introduction to the "way of thinking" and the methodology in Physics, with the help of demonstration experiments. The Chapters treated are Electromagnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena. Whenever possible, examples relevant to the students' main field of study are given.

Objective
Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.

Content
Elektromagnetismus, Elektromagnetische Wellen, Wellenoptik, Strahlenoptik, Quantenoptik, Quantenmechanik, Thermische Eigenschaften, Transportphänomene, Wärmestrahlung

Lecture notes
Skript wird verteilt.

Literature
Friedhelm Kuypers
Physik für Ingenieure und Naturwissenschaftler
Band 2 Elektrizität, Optik, Wellen
Wiley-VCH, 2012
ISBN 3527411445, 9783527411443

701-0071-00L Mathematics III: Systems Analysis

Abstract
The objective of the systems analysis course is to deepen and illustrate the mathematical concepts on the basis of a series of very concrete examples. Topics covered include: linear box models with one or several variables, non-linear box models with one or several variables, time-discrete models, and continuous models in time and space.

Objective
Learning and applying of concepts (models) and quantitative methods to address concrete problems of environmental relevance.

Content
http://www.up.ethz.ch/education/systems-analysis.html

Lecture notes
Overhead slides will be made available through Ilias.

Literature

752-4001-00L Microbiology

Abstract
Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.

Objective
Teaching of basic knowledge in microbiology.

Content

Lecture notes
Wird von den jeweiligen Dozenten ausgegeben.

Literature
Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms

701-0255-00L Biochemistry

Abstract
Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes.

Objective
Students are able to understand - the structure and function of biological macromolecules
- the kinetic bases of enzyme reactions
- thermodynamic and mechanistic basics of relevant metabolic processes
Students are able to describe the relevant metabolic reactions in detail
Content

**Program**

Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
Structure and function of proteins
Carbohydrates
Lipids an biological membranes
Enzymes and enzyme kinetics
Catalytic strategies
Metabolism: Basic concepts and design. Repetition of basic thermodynamics
Glycolysis, fermentation
The citric acid cycle
Oxidative phosphorylation
Fatty acid metabolism

**Lecture notes**

Horton et al. (Pearson) serves as lecture notes.

**Prerequisites / notice**

Basic knowledge in biology and chemistry is a precondition.

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**701-0501-00L Pedosphere**

**Abstract**

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

**Objective**

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

**Content**

Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

**Lecture notes**

Lecture notes can be purchased during the first lecture (15.- SFr)

**Literature**


**Prerequisites / notice**

Prerequisites: Basic knowledge in chemistry, biology and geology.

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**752-6003-00L Introduction to Nutritional Science**

**Abstract**

This course introduces basic concepts of micro- and macronutrient nutrition. Micronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates.

**Objective**

To introduce the students to the both the macro- and the micronutrients.

**Content**

The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism.

**Lecture notes**

There is no script. Powerpoint presentations will be made available.

**Literature**


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**751-1551-00L Ressourcen- und Umweltökonomie**

**Abstract**

Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.
The aim of these lecture is to present the processes controlling the uptake and transport of nutrients and water by the plant, the economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and welfare concepts and market failure.

A general introduction explains the needs of appropriately managing nutrients in plant production. Afterwards, we will study the physiology of plant nutrition. For the part on fertilization we will use the booklet of ACW and ART presenting the recommendations for the fertilization of crops and grassland in Switzerland (GRUDAF/DBF).


Water balance: http://www.tll.de/visuplant/vp_idx.htm


Schubert S 2006 Pflanzenernährung Grundwissen Bachelor Ulmer UTB


Schubert S 2006 Pflanzenernährung Grundwissen Bachelor Ulmer UTB

Pictures of nutrients deficiency symptoms:

ACW and ART presenting the recommendations for the fertilization of crops and grassland in Switzerland (GRUDAF/DBF).

We will distribute a script for the part dealing with the physiology of plant nutrition. For the part on fertilization we will use the booklet of ACW and ART presenting the recommendations for the fertilization of crops and grassland in Switzerland (GRUDAF/DBF).

At the end of the lecture, students know how mineral nutrients and water are taken up through roots and circulate in the plants and what their roles in plants are. They understand the importance of nutrients for yield formation and for crop product quality. They are able to propose fertilization plans adapted for field crops growing under Swiss conditions.

A general introduction explains the needs of appropriately managing nutrients in plant production. Afterwards, we will study the physiology of plant nutrition (nutrient uptake by roots; water and nutrient transports in the plant; physiological roles of nutrients in the plant). Then the role of nutrients for yield formation and their effects on crop quality is dealt with. Finally, the bases of crop fertilization are taught (availability of nutrient in soil; N, P and K fertilization; different types of fertilizers).

Cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

The script and lecture material are provided at: https://moodle-app2.let.ethz.ch/course/view.php?id=140


**Objective**

Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

**Topics are:**

Introduction to resource and environmental economics

Importance of resource and environmental economics

Main issues of resource and environmental economics

Normative basis

Utilitarianism

Fairness according to Rawls

Economic growth and environment

Externalities in the environmental sphere

Governmental internalisation of externalities

Private internalisation of externalities: the Coase theorem

Free rider problem and public goods

Types of public policy

Efficient level of pollution

Tax vs. permits

Command and Control Instruments

Empirical data on non-renewable natural resources

Optimal price development: the Hotelling-rule

Effects of exploration and Backstop-technology

Effects of different types of markets.

Biological growth function

Optimal depletion of renewable resources

Social inefficiency as result of over-use of open-access resources

Cost-benefit analysis and the environment

Measuring environmental benefit

Measuring costs

Concept of sustainability

Technological feasibility

Conflicts sustainability / optimality

Indicators of sustainability

Problem of climate change

Cost and benefit of climate change

Climate change as international ecologcal externality

International climate policy: Kyoto protocol

Implementation of the Kyoto protocol in Switzerland

Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

**Literature**


**Agricultural Natural Sciences**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-6101-00L</td>
<td>Anatomy and Physiology of Man and Animals I</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>M. C. Härdi-Landerer, S. E. Ulbrich</td>
</tr>
<tr>
<td>751-3401-00L</td>
<td>Plant Nutrition I</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>E. Frossard</td>
</tr>
<tr>
<td>751-4501-00L</td>
<td>Phytomedicine: Entomology</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>C. De Moraes</td>
</tr>
</tbody>
</table>
Objective
At the end of this course in Applied Entomology, students will have (1) an overview on herbivore insects (pests) and their natural antagonists in agroecosystems, combined with an insight into ongoing research, and (2) an in-depth understanding of population dynamics and damage development based on selected examples from the areas of plant, animal and public health.

751-4501-01L Phytomedicine: Plant Pathology W 1 credit 1V U. Merz
Abstract
Plant Pathology topics: plant diseases in agroecosystems, categories of pathogens, pathogen life histories, pathogen attack and plant defense, gene-for-gene systems, and disease control strategies. 
Objective
Gain an understanding of the causes and consequences of plant diseases in agroecosystems.
Content
Lecture notes
Lecture notes will be available for purchase at the cost of reproduction.
Literature

751-6301-00L Animal Breeding W 2 credits 2V S. Neuenschwander
Abstract
Introduction to basics of animal breeding. Importance of animal production. Species of livestock and their products, performance recording, functional traits, genetic diversity, breeding goals. Qualitative and quantitative traits. Basic knowledge of breeding methods: genetic and environmental variation, heritability, genetic correlation, estimation of breeding values, selection, mating systems.
Objective
Show the importance of animal production for Swiss and international agriculture. Name the livestock species, their products, systematic classification and breeding and production goals. Describe methods to measure animal performance (performance recording) and functional traits. Define the most important parameters and methods in animal breeding.
Content
Lecture notes
Transparencies and single chapters of textbook are made available on homepage.
Literature
Tierzucht (Willam/Simianer) UTB 3526 (2011)
Additional literature to be announced in the lecture.

Agricultural and Resource Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>751-2001-00L</td>
<td>Area Planning and Regional Development</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>C. Lüscher, B. Buser</td>
</tr>
</tbody>
</table>

Objective
Introduction into Area Planning in Switzerland, basics, legal aspects and instruments. Overview and state of the art. Practical regional development based on concrete experience and projects; basics, legal aspects and state of the art.

Content
Area Planning:
- Basics of area planning
- Overview over existing regulations in Switzerland
- State of the art in Switzerland
- links between area planning and environmental protection

- regional development:
  - Basics for a successful regional development based on personal field experience
  - discussion of the different instruments
  - stake holders and their role in regional politics
  - case studies for developing strategies (in small study groups)

Lecture notes
no script will be delivered, mainly for technical reasons; all necessary stuff will be delivered as papers or via internet.
Literature
no literature
Prerequisites / notice
german spoken (with translation of french and italian technical terms)

751-1311-00L Introduction to Agricultural Management W+ 2 credits 2V R. Finger
Abstract
Vermittlung von betriebswirtschaftlichen Grundlagenwissen und Analyse- und Planungsinstrumenten mit Anwendung auf Unternehmen der Agrar- und Ernährungswirtschaft
Objective
Teilnehmer des Kurses sollen am Ende der Vorlesung i) grundlegende Unternehmensentscheidete strukturieren und analysieren können, ii) verschiedene Analyse- und Planungsinstrumente auf Fragestellungen der Produktionsplanung, Investition und Finanzierung an Beispielen anwenden zu können, iii) verschiedene Werkzeuge zur unternehmerischen Entscheidungsunterstützung anwenden können und iv) die Spezifika von Unternehmen in der Agrar- und Ernährungswirtschaft kennen.

Content
Die Vorlesung geht auf folgende Inhalte, mit spezifischen Anwendungen im Agrar- und Ernährungssektors ein:
- Grundlagen und Ziele unternehmerischen Entscheidens
- Kosten und Leistungsrechnung
- Produktionsrechnung
- Produktionsprogrammplanung
- Investitionsplanung und Finanzierung
- Entscheidungen unter Unsicherheit und Risikomanagement

Lecture notes
Vorlesungsunterlagen werden im Laufe des Semesters zur Verfügung gestellt
Literature

5. Semester

Focus Agricultural Natural Sciences

Focus Agricultural Natural Sciences
<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
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</thead>
<tbody>
<tr>
<td>751-4001-00L</td>
<td>Forage Cropping</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>N. Buchmann, A. Lüscher</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is an introduction into forage cropping and grassland sciences. Topics include: extensive/intensive use, grassland evaluation, grassland maintenance, management using fertilization, cutting, etc. Relationships between site, vegetation composition and management will be explored.</td>
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<tr>
<td>Objective</td>
<td>Die Studierenden werden wichtige Mischungen und Pflanzengemeinschaften mitteleuropäischer Grasslandökosysteme kennen, klassische und aktuelle Arbeiten der Bestandesökologielehre kennen, in der Lage sein, den Einfluss von Umweltfaktoren und Bewirtschaftung nicht nur auf Einzelläden, sondern auf Pflanzenbestände und ihre Erträge abzuschätzen, und üben, ein wissenschaftliches Thema schriftlich prägnant zusammenzufassen.</td>
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<tr>
<td>Content</td>
<td>In diesem Kurs werden die verschiedenen Typen des Futterbaus und die wichtigsten Mischungen, aber auch natürliche Pflanzengemeinschaften in Mitteleuropa vorgestellt (Bestandesbeurteilung). Basierend auf der Ökophysiology von Einzelplanten wird die Ökophysiology von Pflanzenbeständen erarbeitet. Es werden verschiedene Arten der Bewirtschaftung vorgestellt (z. B. Bestandeslenkung durch Düngung, Beweidung, Schnitttermine, etc.) und ihre Auswirkungen auf die Bestandeszusammensetzung und auf die Erträge diskutiert. Feedback-Mechanismen zwischen Umwelt und Futterbausystemen werden angesprochen.</td>
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<tr>
<td>Lecture notes</td>
<td>Handsouts werden auf dem Netz zur Verfügung gestellt.</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Wird in der Veranstaltung angesprochen.</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Course will be given in German. Course builds on the Ertrags- und Ökophysiologie lecture and provides the basics for the Grasslandsystems.</td>
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| 751-4101-00L | Crops                                                                 | W+   | 2    | 2G    | A. Walter, F. Liebisch, W. Richner           |
| Abstract     | Presentation of the central crops of our regions (cereals, oil and fibre plants, legumes, root and tuber plants) with respect to their biology, site requirements, reaction to environmental conditions and farming practice. A few crops of other regions will be discussed for these aspects as well. |
| Objective    | During this course, students acquire essential knowledge on agriculturally relevant aspects of crop biology. Via lectures and ‘hands-on’ teaching elements, differences between species as well as common aspects of different species will be experienced. Thereby, the foundation will be laid for a more intense examination of alternative crops, cropping systems and of procedures to characterize geno- and phenotype. |
| Content      | The relevance of horticulture at the international level will be treated in the first block. Moreover, the relevance of horticulture will be discussed during the second block. |
| Lecture notes| Handsouts will be provided during the lectures by the different teachers. ELBA upload. |
| Literature   | Delivered during the lectures by the different teachers. ELBA upload. |
| Prerequisites / notice | Not needed, maybe specific literature is specified by the different teachers. Language and script: German or French, maybe selected parts in English. |

| 751-4201-00L | Horticulture I                                                        | W    | 2    | 2V    | L. Bertschinger, A. Bühlmann, J.L. Spring   |
| Abstract     | Overview on horticulture (international and national), insights into principles of practical fruit production (pre- and post-harvest), vitiiculture (incl. some hints on wine making), berry production and vegetable production in Switzerland. |
| Objective    | Insights into fruit production (world and Switzerland), particularly ... |
| Content      | During the first block, the focus is on the overview on horticulture. During the second block, the focus is on the aspects of viticulture. |
| Lecture notes| Delivered during the lectures by the different teachers. ELBA upload. |
| Literature   | Not needed, maybe specific literature is specified by the different teachers. Language and script: German or French, maybe selected parts in English. |

| 751-4701-00L | Herbology                                                            | W+   | 2    | 2G    | B. Streit, N. Delabays, U. J. Haas          |
| Abstract     | The focus will be on the basic principles of biology and ecology of weeds, crop-weed interactions and basic knowledge of chemical, physical and biological weed control with their respective (dis-) advantages. Furthermore, students will get an introduction on the mechanisms of weed management in different farming systems and crops. |
| 751-4801-00L | System-Oriented Management of Herbivore Insects I                   | W+   | 2    | 2G    | D. Mazzi                                     |
| Abstract     | The focus is on the potential to assess strategies and tactics of pest management, taking into account the demands from the economy, the environment and the society. Significant agricultural approaches will be explained using practical examples, including prevention using natural resources, surveillance and forecasting, resistance management, as well as product registration, incl. ecotoxicology. |
| Objective    | The students gain a good understanding of fundamental aspects of pest management in agroecosystems. They will have the ability to assess options for action in view of requirements from the economy, the ecology and the society. Further, they will learn to perform searches on relevant issues in pest management, and to critically evaluate case studies. |

| 751-7101-00L | Applied Animal Nutrition                                             | W    | 2    | 2G    | M. Kreuzer, G. Bee, F. Leiber, R. Messakommer, F. Sutter |
| Abstract     | The basics of planning of feeding and formulation of diets incl. the implications on nutrient cycles and balances are taught. In the part dealing with ruminants, forage-based diets and the application of feed formulation programs are central and exercised on-farm. With pigs and poultry, the basics of energy and nutrient requirements are deepened through practical examples. |
| Objective    | The students are able, based on the knowledge they obtain in this course, to deal with problems in the nutrition of ruminants, pigs and poultry on farm. |
| Content      | - Programmteil Wiederkäuer: Einführung in die Winterfütterungsplanung für Milchkühe, Betriebsbesuch (Erfassung aller notwendigen Daten inkl. Futterprobenentnahme für eine konkrete Planung auf einem Praxisbetrieb), Besonderheiten der Milchviehfütterung (Laktationsverlauf, Jahreszeit, etc.); Einführung in den LBL-Fütterungsplan, Möglichkeiten der Futterbeurteilung und -bewertung mit praktischer Beurteilung der gesammelten Proben, Berechnungen und Besprechung Futterungsplan, Aufstellung der Mineralstoffbilanz, Vorführung von PC-Software zur Fütterungsplanung Vorstellen und diskutieren des Fütterungsplanes auf dem Praxisbetrieb durch die Gruppe. |
| Lecture notes| Handsouts in German language will be provided by each lecturer when starting his part of the lecture. |
| Literature   | Die Dozierenden geben in der Lehrveranstaltung die relevante Literatur bekannt. |
| Prerequisites / notice | Blockkurs in Halbtagesform; eingeschlossen sind Betriebsbesuche. Fach mit benoteter Semesterleistung. |

| 751-7103-00L | Animal Feed and Feeding of Ruminant                                 | W+   | 2    | 2V    | M. A. Boessinger                           |
| Abstract     | The focus of this course will be on the basics of animal feed and feeding of ruminants. The basics of planning of feeding and formulation of diets incl. the implications on nutrient cycles and balances are taught. In the part dealing with ruminants, forage-based diets and the application of feed formulation programs are central and exercised on-farm. With pigs and poultry, the basics of energy and nutrient requirements are deepened through practical examples. |
| Objective    | The students are able, based on the knowledge they obtain in this course, to deal with problems in the nutrition of ruminants, pigs and poultry on farm. |
| Content      | - Programmteil Wiederkäuer: Einführung in die Winterfütterungsplanung für Milchkühe, Betriebsbesuch (Erfassung aller notwendigen Daten inkl. Futterprobenentnahme für eine konkrete Planung auf einem Praxisbetrieb), Besonderheiten der Milchviehfütterung (Laktationsverlauf, Jahreszeit, etc.); Einführung in den LBL-Fütterungsplan, Möglichkeiten der Futterbeurteilung und -bewertung mit praktischer Beurteilung der gesammelten Proben, Berechnungen und Besprechung Futterungsplan, Aufstellung der Mineralstoffbilanz, Vorführung von PC-Software zur Fütterungsplanung Vorstellen und diskutieren des Fütterungsplanes auf dem Praxisbetrieb durch die Gruppe. |
| Lecture notes| Handsouts in German language will be provided by each lecturer when starting his part of the lecture. |
| Literature   | Die Dozierenden geben in der Lehrveranstaltung die relevante Literatur bekannt. |
| Prerequisites / notice | Blockkurs in Halbtagesform; eingeschlossen sind Betriebsbesuche. Fach mit benoteter Semesterleistung. |
Die Grundlagen zu aktuellen Problemen der Tiergesundheit und Tierhaltung werden vor diesem Hintergrund verstanden. Die Studierenden sind fähig, mit fundierten Kenntnissen aktuelle Themen zu diskutieren.

### 751-6121-00L Regulatory Physiology

**W** 2 credits  
S. E. Ulbrich

**Abstract**


**Objective**

Die Grundlagen zu aktuellen Problemen der Tiergesundheit und Tierhaltung werden vor diesem Hintergrund verstanden. Die Studierenden sind fähig, mit fundierten Kenntnissen aktuelle Themen zu diskutieren.

### 751-4504-00L Plant Pathology I

**W** 2 credits  
B. McDonald

**Abstract**

Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems.

**Objective**

Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems as a basis for implementing disease management strategies in agroecosystems.

**Content**

Course description: Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

### Lecture Topics and Tentative Schedule

**Week 1**  
No Lecture: First day of autumn semester

**Week 2**  
The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nematode attack strategies and types of damage.

**Week 3**  

**Week 4**  

**Week 5**  
Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.

**Week 6**  
Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, preformed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.

**Week 7**  
Pisatin and pisatin demethylase. Local and systemic acquired resistance, signal molecules.

**Week 8**  
Pathogen effects on food quality and safety.

**Week 9**  
Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics, including resistance, physiology, density, uniformity.

**Week 10**  
Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.

**Week 11**  
Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.

**Week 12**  
Strategies for minimizing disease risks: principles of disease control and management.

**Week 13**  
Disease control strategies: economic thresholds, physical control methods.

**Week 14**  
Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

### Literature


### Prerequisites / notice

Eine Literaturliste ist im Skript enthalten.

### Lecture notes

Script is available in German language and will be provided by each lecturer when starting his part the lecture.

### Lecture notes

Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.
Presentation of basics in planning of agricultural buildings, work economics. This lecture forms the basis for the Agrartechnik II course.

**Basics of strategy & strategic concepts**

2 credits

**Title**

W.+, C. Keller, B. S. Sütterlin

**Abstract**

Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior.

**Objective**

Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior.

**Content**

- Basics of strategy & strategic concepts
- Classic process of strategy process
- Selected alternative processes
- Case studies

**Lecture notes**

Dokuments will be distributed per lecture.

**Literature**

Lombriser Roman & Aplanalp Peter: Strategisches Management

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**Consumer Behaviour I**

752-2120-00L

**W** 2 credits **V**

M. Siegrist, C. Keller, B. S. Sütterlin

**Abstract**

Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior.

**Objective**

Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior.

**Content**

- Basics of structural engineering. Dimensioning of simple supported and cantilevered beams and roof structures. Tension, compression, bending.
- Evaluation of typical roof structures in agricultural buildings.
- Loads: snow, wind, dead and live loads
- Physical properties of building materials: timber, steel, concrete.
- Reinforcement of concrete
- Housing systems for cattle, pigs, poultry, horses
- Storage plants for slurry, manure, feed.
- Planning. Space and functioning programme, building concepts, financing, permit of building, detailed plans, contractors
- Planning and designing exercise.

**Literature**


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**Agricultural Engineering I**

751-8001-00L

**W** 2 credits **V**

M. Schick, M. Sax

**Abstract**

Presentation of basics in planning of agricultural buildings, work economics. This lecture forms the basis for the Agrartechnik II course (indoor and outdoor work processes).

**Objective**

Main objectives: The students acquire comprehensive functional knowledge about agricultural engineering systems (including construction) enabling them to plan and assess the use of those systems in practice.

**Subobjectives:**

- Basics in agricultural construction will show that a professional implementation of functional, animal-friendly, environmentally sound (and economically advantageous) construction of buildings is feasible.
- Profound knowledge of planning tools based on work economics will help the students to correctly plan the substitution of agricultural work by efficient technical solutions.

**Content**

- Part 1: Agricultural building
  - Basics of structural engineering. Dimensioning of simple supported and cantilevered beams and roof structures. Tension, compression, bending.
  - Evaluation of typical roof structures in agricultural buildings.
  - Loads: snow, wind, dead and live loads
  - Physical properties of building materials: timber, steel, concrete.
  - Reinforcement of concrete
  - Housing systems for cattle, pigs, poultry, horses
  - Storage plants for slurry, manure, feed.
  - Planning. Space and functioning programme, building concepts, financing, permit of building, detailed plans, contractors
  - Planning and designing exercise.

**Literature**


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**Managerial Economics Agri-Food Chain: Strategic Concepts**

751-1307-00L

**W** 2 credits **V**

M. Weber, B. Hölttschi

**Abstract**

Learn and exercise strategic concepts in the Agri-Food chain, i.e. theories of economics based decision making combined with entrepreneurial practice.

**Objective**

The main objective is to understand strategic decisions along the value chain in the Agri-Food Chain.

**Content**

- Basics of strategy & strategic concepts
- Classic process of strategy process
- Selected alternative processes
- Case studies

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**Focus Agricultural and Resource Economics**

**Focus Agricultural and Resource Economics**

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**Data:** 06.11.2018 12:57

**Autumn Semester 2016**

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<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Literature</th>
</tr>
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<td>Dokuments will be distributed per lecture. Lombriser Roman &amp; Aplanalp Peter: Strategisches Management</td>
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<tr>
<td>Content</td>
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<tr>
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</tbody>
</table>

#### Consumer Behaviour I

**W** 2 credits 2V M. Siegrist, C. Keller, B. S. Sütteli

**Abstract**
Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior

**Objective**
Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior

#### Agricultural Engineering I

**W** 2 credits 2V M. Schick, M. Sax

**Abstract**
Presentation of basics in planning of agricultural buildings, work economics. This lecture forms the basis for the Agrartechnik II course (indoor and outdoor work processes).

**Objective**
Main objectives: The students acquire comprehensive functional knowledge about agricultural engineering systems (including construction) enabling them to plan and assess the use of those systems in practice.

**Subobjectives:**
Basics in agricultural construction will show that a professional implementation of functional, animal-friendly, environmentally sound (and economically advantageous) construction of buildings is feasible.

**Content**
Part 1: Agricultural building
- Basics of structural engineering. Dimensioning of simple supported and cantilevered beams and roof structures. Tension, compression, bending.
- Evaluation of typical roof structures in agricultural buildings.
- Loads: snow, wind, dead and live loads
- Physical properties of building materials: timber, steel, concrete.
- Reinforcement of concrete
- Housing systems for cattle, pigs, poultry, horses
- Storage plants for slurry, manure, feed.
- Planning. Space and functioning programme, building concepts, financing, permit of building, detailed plans, contractors
- Planning and designing exercise.

P.S.: Indoor work processes: ‘Agrartechnik II’ spring term 2009

Part 2: Work economics
- work-economics-related guiding figures (time measurements, statistical processing, data recording using a work diary, sources of work-economics-related planning data, application for ‘Agroscope FAT’ machine costs lists, ‘LBL’ planning basics, etc.).
- working time models (work and production process level, process comparisons, process optimisation through growth and/or specialising of farm, cooperation with others, work productivity) including PROOF model to calculate time consumption off different procedures
- ‘Agroscope FAT’ (agricultural research station in Tänikon) work budget (integration of modules in entire farm, available field work days and weather risk, farm management-related work and special tasks, use of a detailed or global work budget, comparison of target and actual situation in terms of work economics


#### Microeconomics of the Agriculture and Food Sector

**W**+ 2 credits 2V S. Hirsch

**Abstract**
In this Vorlesung sollen Mikroökonomische Zusammenhänge am Fallbeispiel des Agrar- und Ernährungssektors vermittelt werden. Ziel ist das Verständnis theoretischer mikroökonomischer Methoden und deren Anwendung auf den Ernährungsektor

**Objective**
Zunächst sollen ökonomische Charakteristika des Lebensmittelsektors herausgearbeitet und gegenüber anderen Industriesektoren differenziert werden. Daraufhin sollen theoretische mikroökonomische Modelle und Indikatoren erlautert werden. Insbesondere soll deren Anwendung auf reale Fälle der Schweizer und EU Lebensmittelindustrie vermittelt werden.

**Content**
- Der EU Lebensmittelsektor
- Preiselastizitäten von Angebot und Nachfrage im Ernährungssektor (Marktmacht, Lancaster Modell)
- Gewinnmaximierung
- Wettbewerbsangebot
- Monopol/ Monopolistischer Wettbewerb/ Monopson
- Oligopol (Stackelberg, Cournot, Bertrand)
- Preisbildung/ Preisdiskriminierung
- Kartelle
- Dominante Firma
- Technischer Fortschritt

**Literature**

**Prerequisites / notice**
Empfohlene Vorkenntnisse:
- Grundkenntnisse der Ökonomie/Agrarökonomie
- Vorlesung Einführung in die Mikroökonomie

### Complementary Courses in Agricultural and Resource Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>751-4001-00L</td>
<td>Forage Cropping</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>N. Buchmann, A. Lüscher</td>
</tr>
</tbody>
</table>

**Abstract**
This course is an introduction into forage cropping and grassland sciences. Topics include: extensive/intensive use, grassland evaluation, grassland maintenance, management using fertilization, cutting, etc. Relationships between site, vegetation composition and management will be explored.

**Objective**
Die Studierenden werden wichtige Mischungen und Pflanzengemeinschaften mitteleuropäischer Grasslandökosysteme kennen, klassische und aktuelle Arbeiten der Bestandesökophysiologie kennen, in der Lage sein, den Einfluss von Umweltfaktoren und Bewirtschaftung nicht nur auf Einzelpflanzen, sondern auf Pflanzenbestände und ihre Erträge abzuschätzen, und üben, ein wissenschaftliches Thema schriftlich prägnant zusammenzufassen.
The relevance of horticulture at the international level will be treated in the first block. Sustainable Agroecosystems II

Not needed, maybe specific literature is specified by the different teachers.

Wird in der Veranstaltung angesprochen.

2G

A. Walter, F. Liebisch, W. Richner

Overview on horticulture (international and national), insights into principles of practical fruit production (pre- and post-harvest), viticulture

2G

(1) Get to know methods for field and laboratory investigations in agroecology, (2) Analyze case studies from current agroecological

Insights into fruit production (world and Switzerland), particularly ...
Course description: Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

Lecture Topics and Tentative Schedule

Week 1  No Lecture: First day of autumn semester

Week 2  The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nematode attack strategies and types of damage.


Week 5  Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.

Week 6  Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, preformed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.

Week 7  Pisatin and pisatin demethylase. Local and systemic acquired resistance, signal molecules.

Week 8  Pathogen effects on food quality and safety.

Week 9  Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics, including resistance, physiology, density, uniformity.

Week 10  Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.

Week 11  Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.

Week 12  Strategies for minimizing disease risks: principles of disease control and management.

Week 13  Disease control strategies: economic thresholds, physical control methods.

Week 14  Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.

Methodical Courses

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<tr>
<th>Number</th>
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<tr>
<td></td>
<td>Prerequisite: successful participation in &quot;Farm Placement&quot; (751-0201-00L).</td>
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</table>

Abstract

Die Studierenden kennen die Grundlagen und die Konventionen des wissenschaftlichen Schreibens in den Naturwissenschaften, können wissenschaftliche Literatur suchen und verwalten sowie wissenschaftliche Publikationen analysieren. Sie setzen das Gelernte beim Schreiben eines eigenen Textes um.

Objective

Die Studierenden kennen die Grundlagen und die Konventionen des wissenschaftlichen Schreibens in den Naturwissenschaften. Sie setzen das Gelernte beim Schreiben eines kritischen Literaturberichtes in deutscher Sprache zu einem agrarwissenschaftlichen Thema ihrer Wahl um. Die Lehrveranstaltung bereitet die Studierenden auf weitere schriftliche Arbeiten im Studium der Agrarwissenschaften vor, beispielsweise auf die Bachelor-Arbeit.

Lecture notes

Es wird ein Skript abgegeben.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>751-0441-00L</td>
<td>Scientific Analysis and Presentation of Data</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>W. Eugster</td>
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</table>

Abstract

This lecture gives an introduction to the scientific work with data covering all steps from data entry via statistical analyses to producing correct scientific graphical output. Exercises with the data analysis software R (via RStudio) will provide hands-on opportunities to get acquainted with data analysis and presentation. Field data gathered with Prof. E. Frossard will be used.

Objective

This lecture with exercises gives an introduction to the scientific work with data, starting with data acquisition and ending with statistical analyses as they are often required for a bachelor thesis (descriptive statistics, linear regression etc.). Getting data organized with a spreadsheet program (LibreOffice, Excel) and then transferring them to the open-source R package will be the primary focus. An important aspect will be to learn which graphical representation of data are best suited for the task (how can data be presented clearly and still scientifically correct?)
Tentative Programme:
1. Introduction
2. Data acquisition, data organization, data storage, working with data
3. Graphical presentations I - Spreadsheets
5. Correct and problematic graphical data displays
6. Introduction to ‘R’
7. Data import and graphical presentation
8. Statistical distribution and confidence intervals
9. Statistical tests - Repetition and hands-on applications
10. Linear regressions
11./12. Analysis of Variance
13. ANOVA - Discussion of results with Prof. E. Frossard

Last week of semester: examination (Leistungskontrolle)

Lecture notes
Mainly German (with some English passages from text books)

Prerequisites / notice
Theoretical background in ensemble statistics from the mandatory course in the 4th semester; students should have cleared the examination of that fundamental course to be able to follow

Agricultural Science Practical

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<th>Number</th>
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<td>14 credits</td>
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<td>B. Dorn</td>
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Only for Agricultural Sciences BSc, Programme Regulations 2010.

Abstract
Das agrarwissenschaftliche Praktikum besteht aus dem Betriebsaufenthalt, der Betriebsaufnahme (Betriebsheft) und der agronomischen Fachaufgabe. Die Leistungskontrolle erfolgt über die Rückmeldung zu den einzelnen Bestandteilen des Praktikums.

Objective
The farm placement aims to motivate students towards a system oriented approach to agricultural science, connecting science and practice.

Lecture notes
Das Betriebsheft zur Betriebsaufnahme und weitere Dokumente werden vom Praktikantendienst nach Anfrage zur Verfügung gestellt.

Literature
Merkblätter, Lehrbücher und Software stehen den Studierenden beim Praktikantendienst Agarwissenschaft zur Verfügung.

Prerequisites / notice
Für die Jahrgänge mit Eintritt HS 13, HS14 und HS15 ind Bachelor-Studium gilt ein Übergangsreglement zum Agrarwissenschaftlichen Praktikum.

Bachelor’s Thesis

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<td>O</td>
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Only for Agricultural Sciences BSc, Programme Regulations 2010.

Abstract
It completes the Bachelor program and consists of a scientific project carried out independently under the tutorship of a lecturer at the study program in Agricultural Science.

Objective
The independent writing of a scientific paper/thesis

Content
It consists of a scientific project carried out independently under the tutorship of a lecturer at the study program in Agricultural Science.

Agricultural Sciences Bachelor - Key for Type

<table>
<thead>
<tr>
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Key for Hours

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<td>U</td>
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<td>D</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

Thematic Schwerpunkte:
- Lernen als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wis senstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien, Geschlechtsunterschiede beim Lernen

Folien werden zur Verfügung gestellt.

This course is only apt for students who intend to enrol in the programs "Lehrdiplom" or "Didaktisches Zertifikat". It is about learning in childhood and adolescence.

In this seminar, students establish the scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.

At the end of the seminar, participants will be in a position to:
- describe the scientific fundamentals of test theory and test structure.
- evaluate examples of scientifically-developed tests in their application context.
- if necessary, critically question the performance assessment that they employ in practice and professionalise it still further.

Die konkreten Inhalte des Seminars ergeben sich aufgrund der Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:
- Testentwicklung
- Gütekriterien von Tests
- Aufgabenkonstruktion
- Datenanalyse
- Rasch-Modell
- Internationale Vergleichstests
- Zulassungsverfahren

Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören auch die Handouts der verschiedenen, studentischen Vorträge.

Als Grundlagenliteratur werden folgende Werke empfohlen:
- Weitere Literatur wird in der Lehrveranstaltung genannt.

Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben.

Further Angaben zu den Leistungsanforderungen werden im Rahmen der Startveranstaltung abgegeben und erläutert.

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

851-0242-07L Human Intelligence
Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).
Number of participants limited to 30.
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)."

Abstract
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

Objective
- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

851-0242-08L Research Methods in Educational Science
Number of participants limited to 30.
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)."

Abstract
Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objective
- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

851-0240-16L Colloquium on the Science of Learning and Instruction
In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH).

Objective
- Understand pedagogically relevant findings from the empirical educational sciences

851-0240-22L Coping with Psychosocial Demands of Teaching (EW4 W DZ)
Number of participants limited to 20.
The successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

Abstract
In this class, students will learn concepts and skills for coping with psychosocial demands of teaching

Objective
- Understand pedagogically relevant findings from the empirical educational sciences
- Get information about recent literature on learning and instruction
- Get to know cognitively activating instructions in MINT subjects
- Understand findings relevant for education

Subject Didactics and Professional Training

Number
Title
Type
ECTS
Hours
Lecturers
751-9020-00L Teaching Internship Including Examination Lessons Agricultural Science
Only for students who enrolled from HS 2011 on into TC.
The teaching internship can just be visited if all other courses of TC are completed. Repetition of the teaching internship is excluded even if the examination lessons are to be repeated.

Abstract
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Lecture notes
Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Literature
Wird von der Praktikumslehrperson bestimmt.

Further Subject Didactics

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-9005-00L</td>
<td>Mentored Work Specialised Courses in the Respective O</td>
<td>Subject with an Educational Focus Agricult. Sc A</td>
<td>2 credits</td>
<td>4A</td>
<td>G. Kaufmann, K. Koch, U. Lerch</td>
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</tbody>
</table>

Abstract
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective
The aim is for the students
- to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.
- to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership.
- To try out different options for specialist further training in their profession.

Content
Thematische Schwerpunkte:

Lernformen:

Lecture notes
Eine Anleitung zur mentorierten Arbeit in FV wird zur Verfügung gestellt.

Literature
Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Agricultural Sciences TC - Key for Type

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<th>Key for Type</th>
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<td>O</td>
<td>Compulsory</td>
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<td>W+</td>
<td>Eligible for credits and recommended</td>
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<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<td>Dr</td>
<td>Suitable for doctrate</td>
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Key for Hours

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<tr>
<td>V</td>
<td>lecture</td>
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<td>lecture with exercise</td>
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<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<td>R</td>
<td>revision course / private study</td>
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ECTS
European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
Agroecosystem Sciences Master

► Master Studies (Programme Regulations 2016)
►► Major in Animal Sciences
►►► Disciplinary Competences
►►►► LivestockSystems

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>751-6501-00L</td>
<td>Ruminant Science (HS)</td>
<td>W+</td>
<td>4 credits</td>
<td>4G</td>
<td>M. Kreuzer, M. C. Härdi-Landerer, E. Hillmann, U. Witschi</td>
</tr>
</tbody>
</table>

Abstract
The course provides the scientific basis of the central aspects of reproduction, husbandry and nutrition physiology of ruminants, and of the implications for animal welfare, product quality, breeding programs, and organic livestock systems. Means of knowledge transfer include interdisciplinary approaches, disciplinary parts, web-based learning and self-study.

Objective
At the end of the course the students are able to apply, by a comprehensive understanding of the underlying mechanisms, their knowledge in various fields of ruminant science. They will be able to develop and recommend best strategies for breeding programs, feed formulation, improving forage quality, increasing animal health and welfare etc. They will be trained to carry out interdisciplinary and disciplinary research at the highest level. The course Ruminant Science (FS) offered in spring has a similar structure but is complementary to this course.

Content
Fields (contact hours)
- Introduction: 2 h
- Special topics: 12 h
  - Lameness
  - Fertility in Cows
- Food Intake of Ruminants
- Disciplinary topics: 36 h
  - Ruminant Husbandry: 16 h
  - Ruminant Nutrition Physiology: 10 h
- Reproduction in Ruminants: 8 h
- Lectures held by the students: 4 h

In summary
- Contact hours: 52 h
- Self-study within semester: 30 h (especially preparation for the interdisciplinary courses and the own lecture)
- Self-study in semester break: 38 h
Total: 120 h

Lecture notes
Documentations, links and other materials will be provided at the start of the course

Literature
Information on books and other references will be communicated during the course

Prerequisites / notice
The specialty of this course is that for the first time the animal science disciplines are unified. This is realised with a particular emphasis on interdisciplinary special topics and new forms of teaching. At the same time the essential basics in the central fields are communicated.

The field of Ruminant Science will also be a part of the spring semester (special topics: Organic Ruminant Systems, Tropical Ruminant Systems, Mastitis; disciplinary courses: Cattle, Sheep and Goat Breeding, Ruminant Diseases and Prophylaxis, Ruminant Nutrition and the Environment). However both courses are organized independently.

Conditions for successful participation: Background on animal science from the Bachelor is desired. In order to attend the Minor in Ruminant Science without any animal science background, a realistic self-assessment concerning the need for additional self-study is recommended (e.g. by choosing an appropriate bachelor course which then may be counted as ‘optional courses’ in the master). These efforts depend on the extent to which animal science courses have already been attended in the bachelor.

The control of performance will consist of:
- an own lecture
- a final oral examination with focus on comprehension of the fundamental linkages rather than of specific details

751-6601-00L Pig Science (HS) W+ 3 credits 3V E. Hillmann, M. C. Härdi-Landerer

Abstract
The overall goal of the course is to provide the essential scientific knowledge of the genetic, physiological and special nutritional aspects of pigs metabolism, animal health and behaviour, and of the implications for environment, product quality, housing and animal welfare, and breeding programs.

Objective
Students will
- understand the complex interactions of nutrition, quality traits of products, breeding and reproduction, health management, behaviour and husbandry.
- be trained to understand interdisciplinary and disciplinary research.
- be able to critically analyze published research data.
- be able to present precise scientific reports in oral and written form.

Content
Four main topics in Pig Science:
HS
- Behaviour and Husbandry of pigs: behavioral needs, husbandry related behavioral disorders, design and construction of housing systems in accordance with welfare requirements and legal regulations.
  - Planning of reproductive cycle in practice
  - welfare monitoring in practice
- pigs in organic farming
- Animal Health and Diseases: animal hygiene, immunology/vaccinations, metabolic diseases, diarrhoe, legislation, thermoregulation, important infections, prophylaxis.
  - poster, exam and evaluation
FS
- Special Physiology of Pig Nutrition: food intake; growth; metabolism and digestion at different growth stages; energy and specific nutritional requirements; feeding systems; environmental aspects, etc.
- Genetics: Breeding systems, reproductive techniques, performance tests and recording, etc.
  - oral presentation, exam, evaluation

Lecture notes
Handouts/scripts are distributed by the lecturers.

Literature
Specific literature is indicated by the lecturers.
This course deals with unconventional animals or production forms and specific aspects of keeping them in Europe or, more specifically, in Switzerland. This includes e.g. rare breeds, wild cattle, deer, camels, ostrich and fish. Particular emphasis will be given to the regulations and the problems occurring with import, housing and marketing of the products.

At the end of the course the students are able to describe the conditions of keeping unconventional livestock and to develop recommendations for farmers intending to include niche production into the farm enterprise.

The contact hour part of the course (16 h) is conceptually a block course which is subdivided into one day of lecture and one day of excursion.

A documentation will be provided at the start of the course.

The non-contact hour part (14 h) is to comprehend the information given and to prepare for the examination

The lecture corresponds with the lecture "Ruminant Science" and knowledge in animal health, nutrition and breeding as well as applied ethology and animal welfare are recommended.

The lecture usually is in German, but there is always the possibility to change to English.

### Livestock Biology

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<tbody>
<tr>
<td>751-721-00L</td>
<td>Ruminal Digestion</td>
<td>W+</td>
<td>1</td>
<td>1G</td>
<td>A. Schwarm</td>
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</table>

This course broadens the knowledge in one of the most important aspects of ruminant nutrition: the microbial digestion in the rumen (and in the hindgut). For a comprehensive understanding of the rumen microbial ecosystem, the mechanisms of nutrient fermentation and the synthesis of microbial protein, thorough basics are provided. Apart from lectures, group and laboratory exercises are included.

The course enables students to understand in detail how ruminal digestion works and how this knowledge can be applied to design optimal feeding diets using highly fibrous forages and a variety of other feeds. The students also are able to show how to modify the most important rumen microbes beneficially by nutritional means.

Structure of the contact hour part of the course (14 h):

- 2 h Introduction and blackboard exercise
- 8 h Basic topics in ruminal digestion, lectures and group exercises:
  - Systematics of the microbes involved in microbial digestion
  - Measurement of microbial digestion
  - Interations of microbes and epithelium of the digestive tract
  - Differences between ruminal and hindgut microbial digestion
  - Microbial nutrient degradation and its modification
  - Efficiency of microbial protein synthesis
  - Manipulation of the ruminal digestion
- 2 h Laboratory exercise with a rumen fistulated cow and the Rumen Simulation Technique
- 2 h Final seminar

The non-contact hour part is to comprehend the information given and to prepare either the written report or the oral presentation (cf. "Besonderes")

Lecture notes
Lecture notes are provided via Moodle.

Literature
Will be communicated at the start of the course.

Prerequisites / notice
The course is a balanced mixture of blackboard exercise, laboratory exercise, group exercise, lecture and student seminar presentation.

Credit point associated with grade of either a written report or an oral presentation in the final seminar (both on a self-chosen related topic)

### Livestock Genetics

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<tr>
<td>751-7703-00L</td>
<td>Tropical Animal Nutrition</td>
<td>W+</td>
<td>1</td>
<td>1G</td>
<td>S. Marquardt</td>
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</table>

Farm animals play an important role in most agro/eco - systems, but conditions for a successful management and nutrition in the tropics are diverse. In this course a wide range of aspects are examined.

The aim of this course is to know and understand animal production systems in the different zones of the tropics taking into consideration the local and social structure of the population. We will deal with different aspects of animal nutrition in the tropics.

- Introduction to the tropics
- Special problems and challenges in tropical regions
- Importance of livestock in the tropics
- Animal production and livestock production systems in the tropics
- Feeds available in the tropics
- Tropical pasture systems and their characteristics
- Quality of feeds in the tropics
- Problems and challenges of animal nutrition in the tropics

### Conservation of Animal Genetic Resources

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<tr>
<td>751-6243-00L</td>
<td>Conservation of Animal Genetic Resources</td>
<td>W+</td>
<td>1</td>
<td>1V</td>
<td>H. Signer-Hasler, C. Flury</td>
</tr>
</tbody>
</table>

Conservation of Animal Genetic Resources overviews the distribution, endangerment and conservation of farm animal genetic resources in Switzerland and abroad. The theory is illustrated with numerous examples and the knowledge is deepened in exercises.
Objective

The students
- overview the distribution and endangerment of animal genetic resources on national and international level and they know, where to find the relevant information.
- can explain, what value can be assigned to biodiversity and name reasons, why biodiversity should be conserved.
- know the national and international efforts of the present and the past to conserve biodiversity in the livestock sector.
- can explain what is important concerning the management of small populations.
- can explain differences between species and breeds concerning biodiversity conservation.
- can describe different conservation activities, in particular in situ and ex situ conservation
- can describe current national and international conservation programmes for species and breeds.

751-6305-00L Livestock Breeding and Genomics W 3 credits 3G P. von Rohr

Abstract
Methods for analysing livestock data, in particular for the estimation of breeding values: principles of selection index, introduction to BLUP, application of common models used, relationship matrix, methods for the estimation of variance components, basics of breeding programs. The material will be illustrated via exercises and assignments.

Objective
The students are able to set up design matrices, the relationship matrix and its inverse as well as the Mixed Model equations to estimate BLUP breeding values for smaller examples.

Content
- Selection index (various sources of information, one trait, multiple traits)
- Relationship matrix and its inverse
- BLUP: one trait, repeated observations, multiple traits, economic indices
- Introduction to methods for the estimation of variance components
- Assignments

Lecture notes
Copies of the slides are available on the net.

Literature
To be announced in the lectures.

Methodology Competences
Methods for Scientific Research

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<tr>
<th>Number</th>
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<tr>
<td>751-6241-00L</td>
<td>Laboratory Practical in Molecular Animal Genetics and Inherited Diseases</td>
<td>W+</td>
<td>3 credits</td>
<td>3P</td>
<td>S. Neuenschwander, A. Bratus-Neuenschwander, C. Schelling</td>
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</table>

Abstract
Technologies of molecular animal-, immuno- and biochemical genetics will be shown and applied to selected domestic and farm animals. The students will perform laboratory tests for genome analysis (identification of gene loci, gene mapping), gene expression (mRNA, proteins), diagnostics (analysis of hereditary diseases) and verification of animals and animal products (parentage control, forensics).

Objective
Get to know and apply the basic laboratory methods to systematically identify loci controlling important performance and disease traits and analysis of the molecular nature of variation at the loci. At the end of the course the students are able to understand the underlying mechanisms influencing genetic variations and to analyze gene variants in the laboratory. The students know the importance of the technologies for animal breeding, animal health and quality of animal products in Switzerland and internationally. The matter is illustrated on practical examples.

Content
- Introduction to the course (aims, program, written examination)
- Porcine E.coli test. Determination of the mutation in FUT1
- Sequencing of DNA
- Marker-/microsatellite analyses
- Forensics
- Cytogenetics
- Cell cultures
- Inheritance of coat colour
- Gene expression and animal biotechnology

Contact hours: 42 h
Self-study (preparation for courses and examination): additionally

Lecture notes
Handouts/scripts will be distributed by the lecturers.

Literature

Specific literature will be indicated individually by the lecturers.


Abstract
In this course, different experimental designs will be discussed and various statistical tools will be applied to research questions in agroecosystem sciences. Both manipulative (field and laboratory) experiments and surveys are addressed and students work with a selection of basic techniques and methods to analyse data using a hands-on approach. Methods range from simple t-tests to multi-factorial analyses.

Objective
Students will know various statistical analyses and their application to science problems in their study area as well as a wide range of experimental design options used in environmental and agricultural sciences. They will practice to use statistical software packages (R), understand pros and cons of various designs and statistics, and be able to statistically evaluate their own results as well as those of published studies.
The course program uses a learning-by-doing approach ("hands-on minds-on"). New topics are introduced in the lecture hall, but most of the work is done in the computer lab to allow for the different speeds of progress of the student while working with data and analyzing results. In addition to contact hours exercises must be finalized and handed in for grading. The credit points will be given based on successful assessments of selected exercises.

The tentative schedule contains the following topics:

- Introduction To Experimental Design and Applied Statistics
- Introduction to 'R' / Revival of 'R' Skills
- Designs of Field and Growth Chamber Experiments
- Nonlinear Regression Fits
- Multivariate Techniques: Principal Component Analysis, Canonical Correspondence Analysis (CCA), Cluster Analysis
- ANOVA using linear and mixed effect models
- Error Analysis, Error Propagation and Error Estimation
- Introduction to autoregression and autocorrelations in temporal and spatial data and how to consider them in ANOVA-type analysis

This course does not provide the mathematical background that students are expected to bring along when signing up to this course. Alternatively, students can consider some aspects of this course as a first exposure to solutions in experimental design and applied statistics and then deepen their understanding in follow-up statistical courses.

### Content

- **Practical Course in Molecular Physiology**
  - W+ 3 credits
  - 6P
  - S. Bauersachs, S. E. Ulbrich

**Abstract**

This course is intended to intensify and broaden the knowledge of molecular biology gained during the bachelor lab practical course. It directly allows students to commence a master thesis with a detailed knowledge of pitfalls in experimental setup. It will also sensitize for the awareness of biological and technical variance in experimental research.

**Objective**

The course will be divided into two parts:

- **Experimental part:**
  - Isolation of leukocytes from blood and milk (cattle)
  - Culture of isolated cells and stimulation, e.g., with LPS
  - Extraction of RNA
  - Quantification and quality control of RNA (Nanodrop, Fluorometer, Bioanalyser)
  - Analysis of gene expression by the use of quantitative real-time RT-PCR

- **Theoretical part:**
  - Principles of primary cell culture and transcriptional regulation, methods for analytical detection
  - Bioinformatics (scientific databases, sequence analysis, biostatistics)
  - Presentations by the students (e.g. techniques for analysis of physiological regulatory processes, application examples)

In this practical course the students will achieve a comprehensive understanding of molecular physiology in livestock research. A cell culture experiment using blood and milk leukocytes under pathogen-associated treatment will be performed and the analysis of differential gene expression undertaken. The primary cell culture study will give insights into the laboratory work undertaken in animal physiology research. It will include the general discussion of strategies for an appropriate experimental setup in livestock research and possible methods and tools for the analysis. Hands-on cell culture and harvesting, preanalytical sample preparation and measurement implementation as well as the analysis of differential gene expression, data analysis and statistical evaluation using bioinformatics will be performed. In addition, the students will present talks based on state-of-the-art primary literature about related topics to prepare for the course and to complement the provided information. The course will enable the students to design, perform and evaluate laboratory in vitro investigations of physiological regulatory processes on a cellular level.

### Project Management for Scientific Research

**Number** 751-6001-00L

**Title** Forum: Livestock in the World Food System

- **Type:** W+ 2 credits
- **ECTS:** 1S
- **Hours:**
- **Lecturers:** M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neuenschwander

**Abstract**

This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.

**Objective**

In the Forum "Livestock in the World Food System", a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.

**Content**

The Forum "Livestock in the World Food System" will take place in blocks of 2 hours each. Once the general topic has been selected, it comprises two elements:

- **Element 1. Oral Presentation:** The students form small groups and are lecturers. There are chair persons (moderators) from outside of these small groups and they also head the discussion. The remaining students and lecturers are the audience.

- **Element 2. Scientific writing:**
  - Preparation of a short scientific type of paper from a result table offered by the lecturers; Option 2: preparation of an abstract with limited word count from a scientific paper; Option 3: writing of a critical review of a paper. The students have to select 2 of the three options each. There will be a discussion be a discussion in small groups at two dates.
  - Introductions to both forms of presentation will be offered by lecturers.
  - The preparation of the oral and written presentations takes place to a small part during the 2-h blocks and mainly outside of this time.

**Lecture notes**

No scriptum

**Prerequisites / notice**

Requirements for allocation of the two credit points:

- Theatre presentation (with handout) at the forum
- Delivery of written documents of sufficient quality
- Active participation during the presentations by the other participants
The students will learn the conceptual and methodological background of research in the animal science groups of the Institute of Plant, Animal and Agroecosystem Science. In addition to teaching the theoretical background, the major aim of the course is to integrate the students into the research groups (on job training) and, hence, to focus on the practical application of the knowledge.

- Introduction into the conceptual and methodological basis of research
- Integration of the students into the research groups (on job training)
- Application of the gained knowledge

The students will be integrated into the research groups day-to-day work and will thus deal with all aspects of scientific work. This comprises the planning (conceptually and logistically), execution (data collection, laboratory analyses) and evaluation (statistics, data presentation) of experiments as well as the basics of scientific writing (aim: later publication, Master thesis). The research topics and the range of methodologies vary between the animal science research groups in the Institute of Plant, Animal and Agroecosystem Sciences.

The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.

The full integration in a research group often means to work on weekends. The total time budget is equivalent to about 90 hours. Active participation in group meetings (discussion, presentation) and short written reports about the work conducted are required for the 3 credit points. There are no grades, it is only pass or fail.

#### Major in Plant Sciences

#### Disciplinary Competences

#### Agronomy and Plant Breeding

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-4104-00L</td>
<td>Alternative Crops</td>
<td>W+</td>
<td>2</td>
<td>2V</td>
<td>A. Walter, B. Büter, E. A. Pérez Torres</td>
</tr>
<tr>
<td></td>
<td>Lectures address 2 horticultural cropping systems and value chains, each one in 4 h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated before. An excursion to a research site might be included. In a final colloquio, each group presents a report on their case study and their conclusions. Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.</td>
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</tr>
<tr>
<td>751-4203-00L</td>
<td>Horticultural Science: Case Studies (HS)</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>L. Bertschinger, J. Röst, V. J. U. Zufferey</td>
</tr>
<tr>
<td></td>
<td>Lectures address 2 horticultural cropping systems and value chains, each one in 4 h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated before. An excursion to a research site might be included. In a final colloquio, each group presents a report on their case study and their conclusions. Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.</td>
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<tr>
<td>751-3603-00L</td>
<td>Current Challenges in Plant Breeding</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>B. Studer, A. Hund, University lecturers</td>
</tr>
<tr>
<td></td>
<td>The seminar 'Current challenges in plant breeding' aims to bring together national and international experts in plant breeding to discuss current activities, latest achievements and future prospective of a selected topic/area in plant breeding. The topic this year will be: 'Genome editing: potential and challenges for plant breeding'.</td>
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Objective
The educational objectives cover both thematic competences and soft skills:
- Deepening of scientific knowledge in plant breeding
- Critical evaluation of current challenges and new concepts in plant breeding
- Promotion of collaboration and Master thesis projects with practical plant breeders
- Soft skills:
  - Independent literature research to get familiar with the selected topic
  - Critical evaluation and consolidation of the acquired knowledge in an interdisciplinary team
  - Establishment of a scientific presentation in an interdisciplinary team
  - Presentation and discussion of the teamwork outcome
  - Establishing contacts and strengthening the network to national and international plant breeders and scientists

Content
Interesting topics related to plant breeding will be selected in close collaboration with the working group for plant breeding of the Swiss Society of Agronomy (SSA). For this year, the topic ‘Genome editing: potential and challenges for plant breeding’ was selected.

In the fall semester (November 29, 2016), the enrolled students will meet with the lecturers as well as to four to six tutors, selected according to their expertise in the selected topic (one afternoon, for about three hours). After an input talk by the lecturers, four to six specific questions/aspects will be identified and phrased. The tutors and the enrolled students will be assigned to four to six different groups, to critically evaluate one question/aspect of the selected topic. The students, guided by tutors, will prepare a presentation of 15 minutes (plus 5 minutes discussion) covering their specific question/aspect. Participation on that afternoon will be mandatory.

End of January (January 31, 2017), a one-day seminar on the selected topic will be organized. After one to two keynote speakers (international experts), four invited talks will link the selected topic to practical plant breeding. In the afternoon, the four to six students groups will present and discuss with the experts their specific questions on the selected topic/area. These presentations will be evaluated by the lecturers. The seminar will be public and serve as annual meeting of the SSA working group for plant breeding, bringing together the experts in plant breeding.

The course is designed for a maximum of 15 Master students and 10 PhD students (advertised and recruited via the Zurich-Basel Plant Science Center). For full and active participation, a total of 2 credit/ECTS points will be provided.

Lecture notes / notice
Seminar abstracts

Prerequisites / notice
Participation in the BSc course ‘Pflanzenzüchtung’ is strongly recommended, a completed course in ‘Molecular Plant Breeding’ is highly advantageous.

Crop Health

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-5121-00L</td>
<td>Insect Ecology</td>
<td>W+</td>
<td>2</td>
<td>2</td>
<td>R. R. Kariyat Ramachandran, C. De Moraes, M. Mescher</td>
</tr>
<tr>
<td>751-4811-00L</td>
<td>Alien Organisms in Agriculture</td>
<td>W+</td>
<td>2</td>
<td>2</td>
<td>J. Collatz, M. Meissle</td>
</tr>
<tr>
<td>701-0263-01L</td>
<td>Seminar in Evolutionary Ecology of Infectious Diseases</td>
<td>W+</td>
<td>3</td>
<td>2</td>
<td>D. Croll, S. Bonhoeffer, R. R. Regös</td>
</tr>
<tr>
<td>751-4506-00L</td>
<td>Plant Pathology III</td>
<td>W+</td>
<td>2</td>
<td>2</td>
<td>U. Merz, M. Maurhofer Bringolf</td>
</tr>
</tbody>
</table>

Abstract
This is an introductory course in insect ecology. Students will learn about the ways in which insects interact with and adapt to their abiotic & biotic environments and their roles in diverse ecosystems. The course will entail lectures, outside readings, and critical analysis of contemporary literature.

Objective
Students completing this course should become familiar with the application of ecological principles to the study of insects, as well as major areas of inquiry in this field. Highlighted topics will include insect behavior, chemical and sensory ecology, physiological responses to biotic and abiotic stressors, plant-insect interactions, community and food-web dynamics, and disease ecology. The course will emphasize insect evolution and adaptation in the context of specific interactions with other organisms and the abiotic environment. Examples from the literature incorporated into lectures will highlight the methods used to study insect ecology.

Lecture notes
Provided to students through ILIAS

Literature
Selected required readings (peer reviewed literature, selected book chapters). Optional recommended readings with additional information.

Soft skills:
- Promotion of collaboration and Master thesis projects with practical plant breeders
- Critical evaluation of current challenges and new concepts in plant breeding
- Deepening of scientific knowledge in plant breeding
- Establishing contacts and strengthening the network to national and international plant breeders and scientists

Thematic competences:
- Promotion of collaboration and Master thesis projects with practical plant breeders
- Soft skills:
  - Independent literature research to get familiar with the selected topic
  - Critical evaluation and consolidation of the acquired knowledge in an interdisciplinary team
  - Establishment of a scientific presentation in an interdisciplinary team
  - Presentation and discussion of the teamwork outcome
  - Establishing contacts and strengthening the network to national and international plant breeders and scientists

Data: 06.11.2018 12:57
Autumn Semester 2016
### Biogeochemistry and Sustainable Management

**Number** 751-5101-00L  
**Title** Biogeochemistry and Sustainable Management  
**Type** W+  
**ECTS** 2 credits  
**Hours** 2G  
**Lecturers** N. Buchmann, L. Hörtnagl

**Abstract**  
This course focuses on the interactions between ecology, biogeochemistry, and management of agro- and forest ecosystems, thus, coupled human-environmental systems. Students learn how human impacts on ecosystems via management or global change are mainly driven by effects on biogeochemical cycles and thus ecosystem functioning, but also about feedback mechanisms of terrestrial ecosystems.

**Objective**  
Students will know and understand the complex and interacting processes of ecology, biogeochemistry, and management of agro- and forest ecosystems, and be able to analyze and evaluate the various impacts of different management practices under different environmental conditions, search literature, write and evaluate scientific reports, and be able to coordinate and work successfully in small (interdisciplinary) teams.

**Content**  
Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

**Lecture notes**  
Handouts will be available on the webpage of the course.

**Literature**  
Will be discussed in class.

**Prerequisites / notice**  
Prerequisites: Attendance of introductory courses in plant ecophysiology, ecology, and grassland or forest sciences. Course will be taught in English.

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### Radio-Isotopes in Plant Nutrition

**Number** 751-3405-00L  
**Title** Radio-Isotopes in Plant Nutrition  
**Type** W+  
**ECTS** 3 credits  
**Hours** 2G  
**Lecturers** E. Frossard

**Abstract**  
The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isotope into a system can be done to get some information on the structure of the system. Case studies will be presented to determine element availability. Finally, published studies from other groups will be analyzed and presented by the students.

**Objective**  
At the end of the course the students are familiar with the principles on which radioisotope works are based and they have learned from case studies how radioisotopes can be used to obtain meaningful data. They are aware of the advantages of using radioisotopes in element cycling studies, but also of the risks and open questions related to isotope work.

**Content**  
Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g. exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.). The course will first present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g. number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

**Lecture notes**  
Documents will be distributed during the lecture

**Literature**  
Will be given during the lecture

**Prerequisites / notice**  
The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at: http://www.pe.ipw.agrl.ethz.ch/about/reach

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### Rhizosphere Ecology

**Number** 751-5123-00L  
**Title** Rhizosphere Ecology  
**Type** W+  
**ECTS** 4 credits  
**Hours** 4G  
**Lecturers** H. A. Gamper, T. I. McLaren

**Prerequisites** Only students who have passed the courses 751-3401-00L Pflanzenernährung I and 751-3402-00L Pflanzenernährung II - Integriertes Pflanzenernährungsmangement can be admitted to this course.

**Abstract**  
This course is about the physical, chemical, and biological processes in the rhizosphere and their effect on plant growth. Effects of fertilisers, companion plants, and microbial symbionts, and other microbes on nutrient cycling and plant uptake are discussed. An "intercropping" experiment in the glasshouse is used as a model to check for rhizosphere effects on plant growth and mineral nutrition.

**Objective**  
To gain a holistic understanding of resource-driven and regulatory processes in agricultural and natural ecosystems.  
Develop skills on the critical analysis of scientific papers.  
Define explanatory hypotheses, identify knowledge gaps for further investigations.  
Carry out a multi-disciplinary experiment that involves aspects of soil, (micro-)biology, plant physiology, pathology, and ecology.  
Develop manual skills in the set up of a glasshouse experiment, in soil and plant analyses, and in isolation and DNA-based characterisation of rhizobia.  
Gain insights on basic methods to analyse (bio-)chemical, molecular genetic, and graphical data.  
Discuss and interpret data in the context of the literature.  
Prepare a research report in the format of a scientific paper and a poster in the format of a conference paper, partially alone and partially in small groups, using data obtained from the glasshouse experiment.
This course is designed to stimulate thinking and promote critical analysis of important processes that occur in the rhizosphere. As part of this course, the knowledge acquired will be used for analysing and interpreting experimental data, as well as, preparing a scientific report and conference-type poster.

The course will cover the relative importance of spatial scales and various physicochemical and microbiological dynamics as influenced by roots. We will discuss root traits and activities that influence the immediately root-surrounding soil and thereby contribute to mineral nutrient mobilization and immobilization. An overview of the most relevant root-microbe symbioses for agroecosystems will be provided and root and microbial traits discussed, which could be of use in efforts towards utilization of intercropping and bioinoculants as a possible means of reducing energetically expensive inputs to farming systems. A special emphasis will be given to the importance of physicochemical features of soils and the chemical forms (= species) of elements important for plant uptake.

Practical experience will be gained with setting up a glasshouse experiment, soil and root sampling, basic soil and plant analyses, isolation of rhizobia, determination of the number of colony forming units (CFU), assays to screen for phosphorus and zinc solubilizing bacteria, DNA extraction, PCR amplification, and restriction fragment length polymorphism analysis (RFLP) of host range determining symbiosis-specific genes.

In short, the processes dealt with in this course occur on a small-scale and are generally (bio)chemical and microbiological in nature. Furthermore, they are generally not taken into account using current methods of agronomic management for plant production. However, they are increasingly being recognized as a potentially useful means of obtaining a resource-efficient and hence, economically and environmentally sustainable agricultural system, including for ecosystem restoration. Therefore, the course will invite for critical reflections and exemplary challenges in translating knowledge from scientific studies and ecology into application for plant production.

Literature

- How microbes can feed the world (American Academy of Microbiology) http://academy.asm.org/index.php/browse-all-reports/800-how-microbes-can-help-feed-the-world
- Can microbes feed the world? (Society for general microbiology) http://www.sgm.ac.uk/en/publications/microbiology-today/past-issues.cfm/publication/can-microbes-feed-the-world
- Ecological understanding (Second Edition)

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### Prerequisites / notice
We ask all course attendees of the agricultural sciences to have passed the exams at the end of the lectures Plant Nutrition I and II (Nutrient cycling in agroecosystems) by Prof. E. Frossard. All others, have to have successfully worked through the e-learning module Plant Nutrition I by Prof. E. Frossard: https://moodle-app2.let.ethz.ch/course/view.php?id=279

### 751-5125-00L Stable Isotope Ecology of Terrestrial Ecosystems

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-5125-00L</td>
<td>Stable Isotope Ecology of Terrestrial Ecosystems</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>R. A. Werner, N. Buchmann, A. Gessler</td>
</tr>
</tbody>
</table>

### Abstract
This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to process-oriented ecological research. Topics focus on stable isotopes as indicators for the origin of pools and fluxes, partitioning of composite fluxes as well as to trace and integrate processes. In addition, students carry out a small project during lab sessions.

### Objective
Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know the relevant approaches, concepts and recent results in stable isotope ecology, know how to combine classical and modern techniques to solve ecophysiological or ecological problems, learn to design, carry out and interpret a small Isotope Project, practice to search and analyze literature as well as to give an oral presentation.

### Content
The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools and fluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally.

This course will provide an introduction to the applicability of stable isotopes to ecological research questions. Topics will focus on carbon (13C), nitrogen (15N), oxygen (18O) and hydrogen (2H) at natural isotope abundance and tracer levels. Lectures will be supplemented by intensive laboratory sessions, short presentations by students and computer exercises.

### Lecture notes
Handouts will be available on the webpage of the course.

### Literature
Will be discussed in class.

### Prerequisites / notice
This course is based on fundamental knowledge about plant ecophysiology, soil science, and ecology in general. Course will be taught in English.

### 751-5201-00L Tropical Soils and Land Use

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</thead>
<tbody>
<tr>
<td>751-5201-00L</td>
<td>Tropical Soils and Land Use</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>J. Six, A. Hofmann</td>
</tr>
</tbody>
</table>

### Abstract
This course guides students in analyzing and comprehending tropical agroecosystems. Students gain practical knowledge of field methods, diagnostic tools and survey methods for tropical soils and agroecosystems. An integral part of the course is the two-week field project in Western Kenya, which is co-organized with University of Eldoret (Kenya) and KU Leuven (Belgium).

### Objective
Lectures and exercises:
1. Introduction to international soil classification with focus on tropical soils
2. Soil suitability (chemical, physical and biological fertility) for tropical crops
3. Soil conservation practices and stakeholder involvement
4. Approaches to analyzing tropical agroecosystems

Field project:
5. Overview of the major land use systems in Western Kenya
6. Analysis of agricultural production systems
7. Hands-on training on the use of field methods, diagnostic tools and survey methods
8. Collaboration in international student teams (MSc students from Switzerland, Belgium and Kenya)

### Literature


### Prerequisites / notice
The number of participants is limited to 12 students due to capacity limitations for the field project in Kenya. Selection of participants will be based on (1) the student's motivation statement, (2) successful participation in the BSc lectures "Sustainable Agroecosystems I + II" and (3) related topic for BSc thesis/ tentative topic for MSc thesis. The motivation statement is due in the first week of the semester.

### Methodology Competences

### Seminar in Plant Sciences

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>751-4805-00L</td>
<td>Recent Advances in Biocommunication</td>
<td>W+</td>
<td>2</td>
<td>2S</td>
<td>C. De Moraes</td>
</tr>
</tbody>
</table>

### Abstract
Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods.

### Objective
Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods. Students will engage in discussion and critical analyses of relevant papers and present their evaluations in a seminar setting.

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<tr>
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<tbody>
<tr>
<td>751-5001-00L</td>
<td>Agroecologists without Borders</td>
<td>W+</td>
<td>2</td>
<td>2S</td>
<td>C. Decock, A. Hofmann, J. Six</td>
</tr>
</tbody>
</table>
Abstract
In this seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.

Objective
(1) Students analyze concrete examples of agricultural development projects in tropical agroecosystems.
(2) Students broaden their understanding of environmental and socio-economic challenges of smallholder farmers.
(3) Students articulate complexity and challenges in agricultural development interventions.
(4) Students develop their science communication skills by producing science communication materials in the context of the given case study.

Prerequisites / notice
Students signing up for this class should have a strong interest in tropical agriculture and science communication.

751-5115-00L Current Aspects of Nutrient Cycle in Agro-Ecosystems
W+ 2 credits 1S E. Frossard, A. Oberson Dräyer

Abstract
The seminar concerns current aspects and research related to nutrient cycles in agro-ecosystems. It offers to deepen the knowledge on a specific theme related to nutrients. It is composed by presentations of national and international speakers and by an excursion. The students write a report where they compile the obtained information, relate it to their own knowledge and include literature.

Objective
Listen and understand expert's presentations. Ask questions and contribute to the discussion during the talk sessions and the excursion. Link the information obtained during the seminar with knowledge from previous lessons and with literature searched to complement the matter. Expand the knowledge on nutrient cycles and nutrient management in the agro-ecosystem.

751-4003-01L Current Topics in Grassland Sciences (HS)
W+ 2 credits 2S N. Buchmann

Abstract
Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.

Objective
Students will be able to understand and evaluate experimental design and data interpretation of on-going studies, be able to critically analyze published research results, practice to present and discuss results in the public, and gain a broad knowledge of recent research and current topics in agro- and forest ecosystem sciences.

Content
Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.

Lecture notes
none

Prerequisites / notice
Prerequisites: Basic knowledge of plant ecophysiology, terrestrial ecology and management of agro- and forest ecosystems. Course will be taught in English.

Design, Analysis and Communication of Science

Number Title Type ECTS Hours Lecturers

Abstract
In this course, different experimental designs will be discussed and various statistical tools will be applied to research questions in agroecosystem sciences. Both manipulative (field and laboratory) experiments and surveys are addressed and students work with a selection of basic techniques and methods to analyse data using a hands-on approach. Methods range from simple t-tests to multi-factorial designs of field and growth chamber experiments. Students will know various statistical analyses and their application to science problems in their study area as well as a wide range of experimental design options used in environmental and agricultural sciences. They will practice to use statistical software packages (R), understand pros and cons of various designs and statistics, and be able to statistically evaluate their own results as well as those of published studies.

Objective
Students will know various statistical analyses and their application to science problems in their study area as well as a wide range of experimental design options used in environmental and agricultural sciences. They will practice to use statistical software packages (R), understand pros and cons of various designs and statistics, and be able to statistically evaluate their own results as well as those of published studies.

Content
The course program uses a learning-by-doing approach ("hands-on minds-on"). New topics are introduced in the lecture hall, but most of the work is done in the computer lab to allow for the different speeds of progress of the student while working with data and analyzing results. In addition to contact hours exercises must be finalized and handed in for grading. The credit points will be given based on successful assessments of selected exercises.

The tentative schedule contain the following topics:

- Introduction To Experimental Design and Applied Statistics
- Introduction to 'R' / Revival of 'R' Skills
- Designs of Field and Growth Chamber Experiments
- Nonlinear Regression Fits
- Multivariate Techniques: Principle Component Analysis, Canonical Correspondence Analysis (CCA), Cluster Analysis
- ANOVA using linear and mixed effect models
- Error Analysis, Error Propagation and Error Estimation
- Introduction to autoregression and autocorrelations in temporal and spatial data and how to consider them in ANOVA-type analysis

This course does not provide the mathematical background that students are expected to bring along when signing up to this course. Alternatively, students can consider some aspects of this course as a first exposure to solutions in experimental design and applied statistics and then deepen their understanding in follow-up statistical courses.

Lecture notes
Handouts will be available (in English)

Literature
A selection of suggested additional literature, especially for German speaking students will be presented in the introductory lecture.

Prerequisites / notice
This course is based on the course Mathematik IV: Statistik, passed in the 2nd year and the Bachelor's course "Wissenschaftliche Datenauswertung und Datenpräsentation" (751-0441-00L)

Major in Agriculture Economics

Disciplinary Competences

Decision Making and Management

Number Title Type ECTS Hours Lecturers
363-0403-00L Introduction to Marketing W+ 3 credits 2G F. von Wangenheim

The course is designed to convey a profound understanding of marketing's role in modern firms, its interactions and interfaces with other disciplines, its main instruments and recent trends. Particular attention is given to emerging marketing concepts and instruments, and the role of marketing in technology firms.
After the lecture, students should have knowledge on

1) The definition and role of marketing (marketing basics)
2) Creating marketing insights - understanding customer behavior
   - Theoretical concepts in customer behavior (customer behavior)
   - Analytical means to extend knowledge on customer behavior (marketing research)
   - Strategic tools to quantify customer behavior (CLV, CE)
3) Strategic marketing - translating marketing insights into actionable marketing strategies
   - Segmentation, Targeting, and Positioning
   - Attracting customers (marketing mix, 4Ps)
   - Maintaining profitable customer relations (CRM)

The course is designed to convey a profound understanding of marketing’s role in modern firms, its interactions and interfaces with other disciplines, its main instruments and recent trends. Particular attention is given to emerging marketing concepts and instruments, and the role of marketing in technology firms.

The lecture features a short tutorial that is held at irregularly spaced intervals throughout the semester (approximately every third week). The tutorial is embedded within the lecture and consists of short sessions of about 30 minutes. It serves to illustrate theoretical and methodological concepts from the lecture by walking students through the analysis of real-world data from the telecommunications industry. The case data will be provided so that students practice and apply the concepts of the lecture on their own. The tutorial is held jointly by two Teaching Assistants (Zhiying Cui and Jana Gross) and the professor (Prof. F. v. Wangenheim).

The course focuses on agricultural economic research with particular focus on policy evaluation. We impart insights in the issue of policy evaluation as part of agricultural economics research.

The students are to...
- be capable to conduct evaluations and critically reflect evaluation results
- get insights in agricultural economic research of the national research institutions by visiting Agroscope and the Research Institute of Organic Agriculture (FiBL)
- be capable to conduct evaluations and critically reflect evaluation results
- apply knowledge gained from other courses with respect to the focus theme
- consider strengths, weaknesses and the application of research approaches
- study scientific literature of the focus theme
- have a critical look at different angles of agri-economic research

Weekly readings, distributed in class (via Moodle)


Textbooks:
2. Strategic marketing - translating marketing insights into actionable marketing strategies
   - Segmentation, Targeting, and Positioning
   - Attracting customers (marketing mix, 4Ps)
   - Maintaining profitable customer relations (CRM)

Resource Economics and Agricultural Policy

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-2903-00L</td>
<td>Evaluation of Agricultural Policies</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>M. Stolze, S. Mann</td>
</tr>
<tr>
<td>751-2205-00L</td>
<td>Advanced Management in the Agri-Food-Chain</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>M. Weber</td>
</tr>
<tr>
<td>751-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W+</td>
<td>2</td>
<td>2V</td>
<td>M. Siegrist, C. Hartmann</td>
</tr>
<tr>
<td>701-1651-00L</td>
<td>Environmental Governance</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>E. Lieberherr, G. de Buren, R. Schweizer</td>
</tr>
</tbody>
</table>

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 28 of 1571
To understand how an environmental problem may (not) become a policy and explain political processes, using basic concepts and techniques from political science.

To analyze the evolution as well as the key elements of environmental governance.

Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of 'environmental governance' and how legitimate and effective are these approaches in addressing persistent environmental challenges?

We will mostly work with readings from the following books:

A detailed course schedule will be made available at the beginning of the semester.

We recommend that students have (a) three-years BSc education of a (technical) university; (b) successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

## Development and International Policy

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-2103-00L</td>
<td>Socioeconomics of Agriculture</td>
<td>W+</td>
<td>2</td>
<td>2V</td>
<td>S. Mann</td>
</tr>
</tbody>
</table>
| Abstract     | The main part of this lecture will examine constellations where hierarchies, markets or cooperation have been observed and described in the agricultural sector. On a more aggregated level, different agricultural systems will be evaluated in terms of main socioeconomic parameters like social capital or perceptions.  
  
  
  Students should be able to describe the dynamics of hierarchies, markets and cooperation in an agricultural context. |
| Objective    | Groups, identities and utility maximization - some conceptual foundations  
  Micro-Socioeconomics: Hierarchy, cooperation and markets  
  Macro-Socioeconomics: Varieties of Capitalism  
  Agricultural Administration: Path dependencies and efficiency issues  
  Causes and Impacts of farm succession  
  Occupational Choice in the farming sector  
  System Choice and segregation (organic, GMO etc.)  
  The economics of rural areas  
  Common Resource Management in Alpine Farming  
  Agricultural Cooperatives  
  Societal perceptions of agriculture  
  Perceptions of farming from within  
  Varieties of agricultural systems and policies |
| Content      | Lecture slides and additional course material will be provided throughout the semester.  
  Literature  
  see script |
| Lecture notes| Literature  
  - Prerequisites / notice |
| Literature   | Basic economic knowledge is expected. |
| Prerequisites / notice | |
| 851-0626-01L | International Aid and Development | W+   | 2    | 2V    | I. Günther |
| Abstract     | The course gives economic and empirical foundations for a sound understanding of the instruments, prospects and limitations of international development aid.  
  Students have a theoretically and empirically sound understanding of the prospects and limitations of international development aid.  
  Students are able to critically discuss the various aid instruments of bi-and multilateral donors and NGOs.  
  Students will have an introductory course to international environmental politics (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy) |
| Objective    | Introduction to the Determinants of Underdevelopment; History of Aid; Aid and Development: Theories and Empirics; Political Economy of Aid; Experience and Impact of Aid; New Instruments of Aid: e.g. Micro-Finance, Budget-Support; Fair-Trade.  
  Articles and book abstracts will be uploaded to a course website. |
| Literature   | This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.  
  The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems. |
| Prerequisites / notice | particularly suitable for students of D-ITET, D-USYS |
The idea of this course is to familiarize students with instrumental variables estimation of linear regression models and the estimation of
The course is open to all ETH students. Participation does not require previous coursework in the social sciences.
After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around
90 hours (meetings, reading assignments, preparation of test).

Lecture notes
Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based
system of ETH is compulsory.

Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click
here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course
materials can be addressed to Mike Hudecheck (Mike.Hudecheck@student.ethz.ch). All assigned papers must be read ahead of
the respective meeting. Following the course on the basis of on-line slides and papers alone is not sufficient. Physical presence in the
classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GESS library at
the IFW building, Haldeneggsteig 4, B-floor, or in the library of D-USYS.

Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click
here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course
materials can be addressed to Mike Hudecheck (Mike.Hudecheck@student.ethz.ch).

Prerequisites / notice
None

Methods in Agricultural Economics

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>363-0305-00L</td>
<td>Empirical Methods in Management</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>A. Scherer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.</td>
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</table>
| Objective  | - Ability to formulate research questions and designing an appropriate study  
- Ability to collect and analyze data using a variety of methods  
- Ability to critically assess the quality of empirical research in management  
- Applied knowledge of empirical methods through out-of-class assignments |
| Content    | 1) Introduction to empirical management research  
2) Research designs: exploratory, descriptive, experimental  
3) Measurement and scaling  
4) Data collection and sampling  
5) Data analysis methods  
6) Reporting and presenting empirical research |

Prerequisites / notice
Assignments and projects: This course includes out-of-class assignments and projects to give students some hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. A student will have at least one week to work on each assignment. Students are expected to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned-in on time.

Class participation: Class participation is encouraged and can greatly improve students' learning in this class. In this spirit, students are expected to attend class regularly and come to class prepared.

Intermediate Econometrics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0585-00L</td>
<td>Intermediate Econometrics</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>M. Kesina</td>
</tr>
<tr>
<td>Abstract</td>
<td>The idea of this course is to familiarize students with instrumental variables estimation of linear regression models and the estimation of models with limited dependent variables as well as of nonlinear regression models. While most of the material covered will pertain to cross-sectional data, we will also work on selected issues with panel data.</td>
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<tr>
<td>Objective</td>
<td>I will provide STATA programs and show the execution thereof. After having participated in this course, students will be able to carry out simple research projects and understand the basics of intermediate econometrics. In particular, they will be able to write simple programs in STATA and to qualify their own and others' regression output relating to problems covered.</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Cameron and Pravin K. Trivedi. Microeconometrics: Methods and Applications.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Wooldridge, J. M. Microeconometrics: Methods and Applications.</td>
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</table>

Risk Analysis and Risk Management in Agriculture

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-0423-00L</td>
<td>Risk Analysis and Risk Management in Agriculture</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>R. Finger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Agricultural production is exposed to various risks which are important for decisions taken by farmers and other actors in the agri-food sector. Moreover, risk management is indispensable for all actors. This course introduces modern concepts on decision making under risk and recent developments in risk management. The focus of this course is on agricultural production.</td>
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</tbody>
</table>
| Objective  | - to develop a better understanding of decision making under uncertainty and risk;  
- to gain experience in different approaches to analyze risky decisions;  
- to develop an understanding for different sources of risk in agricultural production;  
- to understand the crucial role of subjective perceptions and preferences for risk management decisions;  
- to get an overview on risk management in the agricultural sector; with a particular focus on insurance solutions |
| Content    | - Quantification and measurement of risk  
- Risk preferences, expected utility theory and alternative models of risk behavior  
- Concepts on the decision making under risk  
- Production, investment and diversification decisions under risk  
- Risk management in agriculture |
| Lecture notes | Handouts will be distributed in the lecture and available on the moodle.  
- knlowledge of basic concepts of probability theory and microeconomics |

Dynamic Simulation in Agricultural and Regional Economics

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-1573-00L</td>
<td>Dynamic Simulation in Agricultural and Regional Economics</td>
<td>W+</td>
<td>1</td>
<td>1V</td>
<td>B. Kopainsky</td>
</tr>
<tr>
<td>Abstract</td>
<td>Students in this class develop a dynamic simulation model that represents the basic mechanisms underlying food security in developing countries in a highly aggregated way. Students then proceed to extending the simulation model with one policy to improve food security and they analyze the dynamic impacts of this policy on production and environmental outcomes.</td>
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</table>
Finding solutions: what is complexity, problem solving cycle.

Implementing solutions: project management, critical path method, quality control feedback loop.

Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption

A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics

Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Lecture notes
Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.

The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

Prerequisites / notice
Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

401-0647-00L Introduction to Mathematical Optimization W 5 credits 2V+1U D. Adjaiashvili

Objective
The goal of the course is to obtain a good understanding of some of the most fundamental mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems. The students will also practice applying the learned models to problems in engineering.

Content
Topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...)
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...)
- Modelling with mathematical optimization: applications of mathematical programming in engineering.

Lecture notes
Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.

Prerequisites / notice
Students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

751-1575-00L Sectoral Programming in Agricultural and Regional Economics W 1 credit 1V C. Flury, R. Huber

Professional Internship

Minors

Agricultural Economics and Policy

Number Title Type ECTS Hours Lecturers
751-2903-00L Evaluation of Agricultural Policies W 3 credits 2G M. Stoize, S. Mann

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 31 of 1571
Abstract
The course focuses on agricultural economic research with particular focus on policy evaluation. We impart insights in the issue of policy evaluation as part of agricultural economics research.

Objective
Focus: Policy Evaluation
- have a critical look at different angles of agri-economic research
- study scientific literature of the focus theme
- consider strengths, weaknesses and the application of research approaches
- apply knowledge gained from other courses with respect to the focus theme
- get insights in agricultural economic research of the national research institutions by visiting Agroscope and the Research Institute of Organic Agriculture (FiBL)
- be capable to conduct evaluations and critically reflect evaluation results

Content
Unit: Subject
- 01: Introduction in the issue of policy evaluation
- 02: The normative frame for policy evaluation
- 03: Evaluation of public policies
- 04: Context and use of evaluations
- 05: Quantitative policy evaluation
- 06: Qualitative policy evaluation
- 07: Group work
- 08: Agricultural Economics Research at ART
- 09: Agricultural Economics Research at FiBL
- 10: Examination, Feedback

Lecture notes
Handouts (power point presentations)

Literature
1) Bussmann Werner, Klöti Ulrich und Knoepfel Peter, 2004 (Hrsg). Einführung in die Politikevaluation. Helbling & Lichtenhahn. In German language. Will be provided by the lectures in unit 01.

Prerequisites / notice
- Unit 08: 1 day course at Agroscope in Tänikon, 8356 Ettenhausen, www.agroscope.admin.ch
- Unit 09: 1 day course at FiBL in 5070 Frick, www.fibl.org

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751-2205-00L Advanced Management in the Agri-Food-Chain

Abstract
Advanced Management in the Agri-Food-Chain (Vorlesung wird in deutscher Sprache abgehalten.)

Objective
After the lecture the students ...
... know the characteristics and consequences of complexity in the organizational world,
... know and can apply selected comprehensive models for managing in complex situations,
... know possible practical applications and examples of the treated contents to organizations in the Agri-Food Chain and...
... are able to deepen the relevant topics in an autonomous way.

Content
In the lecture the following contents will be treated:
- State, reasons and effects of complexity in the organizational world.
- A basic framework for shaping and governing intelligent organizations.
- Selected contemporary models for managing in the complex organizational world.
- Transfer and adaption of the models to organizations in the Agri-Food Chain.

Lecture notes
Reader with selected contents.

Prerequisites / notice
- Vorlesung “Management” in D-USYS
- Vorlesung “Managerial Economics Agri-Food Chain: Strategische Konzepte” in D-USYS

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752-2122-00L Food and Consumer Behaviour

Abstract
This course focuses on food consumer behavior, consumer’s decision-making processes and consumer’s attitudes towards food products.

Objective
The course provides an overview about the following topics: Factors influencing consumer’s food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues

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751-2103-00L Socioeconomics of Agriculture

Abstract
The main part of this lecture will examine constellations where hierarchies, markets or cooperation have been observed and described in the agricultural sector. On a more aggregated level, different agricultural systems will be evaluated in terms of main socioeconomic parameters like social capital or perceptions.

Objective
Students should be able to describe the dynamics of hierarchies, markets and cooperation in an agricultural context.

Content
Groups, identities and utility maximization - some conceptual foundations
- Micro-Socioeconomics: Hierarchy, cooperation and markets
- Macro-Socioeconomics: Varieties of Capitalism
- Agricultural Administration: Path dependencies and efficiency issues
- Causes and Impacts of farm succession
- Occupational choice in the farming sector
- System Choice and segregation (organic, GMO etc.)
- The economics of rural areas
- Common Resource Management in Alpine Farming
- Agricultural Cooperatives
- Societal perceptions of agriculture
- Perceptions of farming from within
- Varieties of agricultural systems and policies

Lecture notes

Literature
see script

Prerequisites / notice
Basic economic knowledge is expected.
The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of radioisotopes can be used to obtain meaningful data. They are aware of the advantages of using radioisotopes in element cycling studies, but also of the risks and open questions related to isotope work.

At the end of this course the students are familiar with the principles on which radioisotope works are based and they have learned from evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.

Class participation: Class participation is encouraged and can greatly improve students’ learning in this class. In this spirit, students are expected to attend class regularly and come to class prepared.

Objective
- Students learn the basic theory and practice of dynamic simulation
- Students can develop, analyze and extend a dynamic simulation model and interpret its results.
- By applying the developed simulation model, students gain insights into food security issues. They also learn to recognize the benefits and pitfalls of dynamic simulation, both from a theoretical and an applied perspective.

Lecture notes
slides (will be provided during the class)

Literature
articles and papers (will be provided during the class)

751-0423-00L  
**Risk Analysis and Risk Management in Agriculture**  
W 3 credits  2G  R. Finger

**Abstract**
Agricultural production is exposed to various risks which are important for decisions taken by farmers and other actors in the agri-food sector. Moreover, risk management is indispensable for all actors. This course introduces modern concepts on decision making under risk and recent developments in risk management. The focus of this course is on agriculture applications.

**Objective**
- to develop a better understanding of decision making under uncertainty and risk;
- to gain experience in different approaches to analyze risky decisions;
- to develop an understanding for different sources of risk in agricultural production;
- to understand the crucial role of subjective perceptions and preferences for risk management decisions;
- to get an overview on risk management in the agricultural sector, with a particular focus on insurance solutions

**Content**
- Quantification and measurement of risk
- Risk preferences, expected utility theory and alternative models of risk behavior
- Concepts on the decision making under risk
- Production, investment and diversification decisions under risk
- Risk management in agriculture

**Lecture notes / notice**
Handouts will be distributed in the lecture and available on the moodle.

**Prerequisites**
knowledge of basic concepts of probability theory and microeconomics

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**363-0305-00L  
**Empirical Methods in Management**  
W 3 credits  2G  A. Scherer

**Abstract**
Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.

**Objective**
- Ability to formulate research questions and designing an appropriate study
- Ability to collect and analyze data using a variety of methods
- Ability to critically assess the quality of empirical research in management
- Applied knowledge of empirical methods through out-of-class assignments

**Content**
1) Introduction to empirical management research
2) Research designs: exploratory, descriptive, experimental
3) Measurement and scaling
4) Data collection and sampling
5) Data analysis methods
6) Reporting and presenting empirical research

**Prerequisites / notice**
Assignments and projects: This course includes out-of-class assignments and projects to give students some hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. Students will have at least one week to work on each assignment. Students are expected to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned in on time.

Class participation: Class participation is encouraged and can greatly improve students’ learning in this class. In this spirit, students are expected to attend class regularly and come to class prepared.
Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g. exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.). The course will first present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g. number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

Lecture notes
Documents will be distributed during the lecture

Literature
Will be given during the lecture

Prerequisites / notice
The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at:
http://www.pe.ipw.agrl.ethz.ch/about/reach

751-5123-00L Rhizosphere Ecology
W 4 credits 4G H. A. Gamper, T. I. McLaren
Number of participants limited to 18.

Prerequisites: Only students who have passed the courses 751-3401-00L Pflanzenernährung I and 751-3402-00L Pflanzenernährung II - Integriertes Nährstoffmanagement can be admitted to this course.

Abstract
This course is about the physical, chemical, and biological processes in the rhizosphere and their effect on plant growth. Effects of fertilisers, companion plants, and microbial symbionts, and other microbes on nutrient cycling and plant uptake are discussed. An "intercropping" experiment in the glasshouse is used as a model to check for rhizosphere effects on plant growth and mineral nutrition.

Objective
To gain a holistic understanding of resource-driven and regulatory processes in agricultural and natural ecosystems.
Develop skills on the critical analysis of scientific papers.
Define explanatory hypotheses, identify knowledge gaps for further investigations.
Carry out a multi-disciplinary experiment that involves aspects of soil, (micro-)biology, plant physiology, pathology, and ecology.
Develop manual skills in the set up of a glasshouse experiment, in soil and plant analyses, and in isolation and DNA-based characterisation of rhizobia.
Gain insights on basic methods to analyse (bio-)chemical, molecular genetic, and graphical data.
Discuss and interpret data in the context of the literature.
Prepare a research report in the format of a scientific paper and a poster in the format of a conference paper, partially alone and partially in small groups, using data obtained from the glasshouse experiment.

Content
This course is designed to stimulate thinking and promote critical analysis of important processes that occur in the rhizosphere. As part of this course, the knowledge acquired will be used for analysing and interpreting experimental data, as well as, preparing a scientific report and conference-type poster.

The course will cover the relative importance of spatial scales and various physicochemical and microbiological dynamics as influenced by roots. We will discuss root traits and activities that influence the immediately root-surrounding soil and thereby contribute to mineral nutrient mobilization and immobilization. An overview of the most relevant root-microbe symbioses for agroecosystems will be provided and root and microbial traits discussed, which could be of use in efforts towards utilization of intercropping and bioinoculants as a possible means of reducing energetically expensive inputs to farming systems. A special emphasis will be given to the importance of physicochemical features of soils and the chemical forms (= species) of elements important for plant uptake.

Practical experience will be gained with setting up a glasshouse experiment, soil and root sampling, basic soil and plant analyses, isolation of rhizobia, determination of the number of colony forming units (CFU), assays to screen for phosphorus and zinc solubilizing bacteria, DNA extraction, PCR amplification, and restriction fragment length polymorphism analysis (RFLP) of host range determining symbiosis-specific genes.

In short, the processes dealt with in this course occur on a small-scale and are generally (bio)chemical and microbiological in nature. Furthermore, they are generally not taken into account using current methods of agronomic management for plant production. However, they are increasingly being recognized as a potentially useful means of obtaining a resource-efficient and hence, economically and environmentally sustainable agricultural system, including for ecosystem restoration. Therefore, the course will invite for critical reflections and exemplify challenges in translating knowledge from scientific studies and ecology into application for plant production.

Lecture notes
For documentation, lecture slides and laboratory protocols will continuously be uploaded to the directory '751-5123-00L Rhizosphere Ecology' on the electronic document exchange platform ILIAS, LDA-ELBA:
Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know


This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to

Stable Isotope Ecology of Terrestrial Ecosystems

Objective

Abstract

This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to

Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know

We ask all course attendees of the agricultural sciences to have passed the exams at the end of the lectures Plant Nutrition I and II


How microbes can feed the world (American Academy of Microbiology) http://academy.asm.org/index.php/browse-

Can microbes feed the world? (Society for general microbiology) http://www.sgm.ac.uk/en/publications/microbiology-

Popular science entries to the significance of processes in the rhizosphere:


How microbes can feed the world (American Academy of Microbiology) http://academy.asm.org/index.php/browse-

Can microbes feed the world? (Society for general microbiology) http://www.sgm.ac.uk/en/publications/microbiology-


Prerequisites / notice

We ask all course attendees of the agricultural sciences to have passed the exams at the end of the lectures Plant Nutrition I and II

(Nutrient cycling in agroecosystems) by Prof. E. Frossard. All others, have to have successfully worked through the e-learning module

Plant Nutrition I by Prof. E. Frossard: https://moodle-app2.let.ethz.ch/course/view.php?id=279

Remark: The course is designed to be complementary to those on Radioisotopes in Plant Nutrition (751-3405-00L), and Nutrient Fluxes in

Soil-Plant Systems (751-3404-00L), although some thematic overlaps cannot be avoided. Special emphasis is given to plant-microbe-soil

interactions and an appreciation of whole plant functioning in the ecological context. You will familiarize yourself with bacterial isolation,

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In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture.

**The seminar ‘Current challenges in plant breeding’ aims to bring together national and international experts in plant breeding to discuss current activities, latest achievements and future prospective of a selected topic/area in plant breeding.**

1. **Objective**
   - The educational objectives cover both thematic competences and soft skills:
     - Thematic competences:
       - Deepening of scientific knowledge in plant breeding
       - Critical evaluation of current challenges and new concepts in plant breeding
       - Promotion of collaboration and Master thesis projects with practical plant breeders
     - Soft skills:
       - Independent literature research to get familiar with the selected topic
       - Critical evaluation and consolidation of the acquired knowledge in an interdisciplinary team
       - Establishment of a scientific presentation in an interdisciplinary team
       - Presentation and discussion of the teamwork outcome
       - Establishing contacts and strengthening the network to national and international plant breeders and scientist
   - Interesting topics related to plant breeding will be selected in close collaboration with the working group for plant breeding of the Swiss Society of Agronomy (SSA). For this year, the topic ‘Genome editing: potential and challenges for plant breeding’ was selected.

2. **Content**
   - In the fall semester (November 29, 2016), the enrolled students will meet with the lecturers as well as four to six tutors, selected according to their expertise in the selected topic (one afternoon, for about three hours). After an input talk by the lecturers, four to six specific questions/aspect will be identified and phrased. The tutors and the enrolled students will be assigned to four to six different groups, to critically evaluate one question/aspect of the selected topic. The students, guided by tutors, will prepare a presentation of 15 minutes (plus 5 minutes discussion) covering their specific question/aspect. Participation on that afternoon will be mandatory.

   - End of January (January 31, 2017), a one-day seminar on the selected topic will be organized. After one to two keynote speakers (international experts), four invited talks will link the selected topic to practical plant breeding. In the afternoon, the four to six students groups will present and discuss with the experts their specific questions on the selected topic/area. These presentations will be evaluated by the lecturers. The seminar will be public and serve as annual meeting of the SSA working group for plant breeding, bringing together the experts in plant breeding.

   - The course is designed for a maximum of 15 Master students and 10 PhD students (advertised and recruited via the Zurich-Basel Plant Science Center). For full and active participation, a total of 2 credit/ECTS points will be provided.

3. **Lecture notes**
   - Seminar abstracts

4. **Literature**
   - Peer-reviewed research articles, selected according to the selected topic/area.

5. **Prerequisites / notice**
   - Participation in the BSc course ‘Pflanzenzüchtung’ is strongly recommended, a completed course in ‘Molecular Plant Breeding’ is highly advantageous.
The students will learn and train preparation skills for microscopy, acquire knowledge of selected diseases (identification, biology of pathogens, epidemiology) and understand the corresponding integrated control measures practiced in Swiss agriculture. Knowledge of selected diseases (identification, biology of pathogens, epidemiology) and understanding the corresponding integrated control measures practiced in Swiss agriculture.

The course will partly be an e-learning exercise (with computers).

Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

The course will be in German (specific nomenclature).

The course is an introductory course in insect ecology. Students will learn about the ways in which insects interact with and adapt to their abiotic & biotic environments and their roles in diverse ecosystems. The course will entail lectures, outside readings, and critical analysis of contemporary literature.

Students completing this course should become familiar with the application of ecological principles to the study of insects, as well as major areas of inquiry in this field. Highlighted topics will include insect behavior, chemical and sensory ecology, physiological responses to biotic and abiotic stressors, plant-insect interactions, community and food-web dynamics, and disease ecology. The course will emphasize insect evolution and adaptation in the context of specific interactions with other organisms and the abiotic environment. Examples from the literature incorporated into lectures will highlight the methods used to study insect ecology.

C. De Moraes, M. Mescher

Alien Organisms in Agriculture

751-4811-00L

Abstract

The course focuses on alien organisms in agriculture as well as the scientific assessment and regulatory management of their effects on the environment and agricultural production.

Students will understand the consequences arising from the unintentional or deliberate introduction of alien organisms into agricultural systems. They will be able to understand the concept of environmental risk assessment and be able to evaluate risk management options.

Alien organisms in agriculture is a topic that receives an increasing awareness among farmers, agricultural scientists, regulators and the general public. Students of this course will learn about the nature of alien organisms such as invasive species, biocontrol organisms and genetically modified organisms. With a particular focus on arthropods, plants and their interactions we will look at the potential threats the novel organisms pose, the benefits they provide and how both of these effects can be scientifically assessed. Students will learn how the topic of alien organisms in agriculture is intrinsically tied to policy making and regulation and get to know current examples and future challenges in research. In the last part of the course students will be able to apply the acquired knowledge in a practical exercise (case study).

Material will be distributed during the course.

Lecture notes

701-0263-01L

Seminar in Evolutionary Ecology of Infectious Diseases

Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

Publications and class notes can be downloaded from a web page announced during the lecture.

Lecture notes

751-4506-00L

Plant Pathology III

Identification based on host, symptoms and micro-morphology, completed with life cycles and related control measures of the most important fungal diseases and their causal pathogens of annual and perennial crops with agricultural significance.

The students will learn and train preparation skills for microscopy, acquire knowledge of selected diseases (identification, biology of pathogens, epidemiology) and understand the corresponding integrated control measures practiced in Swiss agriculture.

The course will partly be an e-learning exercise (with computers).

The course will be in German (spec. nomenclature).

Agroecologists without Borders

751-5001-00L

In this seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.

(1) Students analyze concrete examples of agricultural development projects in tropical agroecosystems.
(2) Students broaden their understanding of environmental and socio-economic challenges of smallholder farmers.
(3) Students articulate complexity and challenges in agricultural development interventions.
(4) Students develop their science communication skills by producing science communication materials in the context of the given case study.

Students signing up for this class should have a strong interest in tropical agriculture and science communication.

Lecturers

C. Decock, M. Maurhofer Bringolf

C. De Moraes, M. Mescher

751-5121-00L

Insect Ecology

W 2 credits 2V

This is an introductory course in insect ecology. Students will learn about the ways in which insects interact with and adapt to their abiotic & biotic environments and their roles in diverse ecosystems. The course will entail lectures, outside readings, and critical analysis of contemporary literature.

Objective

Students completing this course should become familiar with the application of ecological principles to the study of insects, as well as major areas of inquiry in this field. Highlighted topics will include insect behavior, chemical and sensory ecology, physiological responses to biotic and abiotic stressors, plant-insect interactions, community and food-web dynamics, and disease ecology. The course will emphasize insect evolution and adaptation in the context of specific interactions with other organisms and the abiotic environment. Examples from the literature incorporated into lectures will highlight the methods used to study insect ecology.

Lecture notes

Provided to students through ILIAS

Literature

Selected required readings (peer reviewed literature, selected book chapters). Optional recommended readings with additional information.

751-5001-00L

Functioning of Soil Systems

Number

Title

Type ECTS Hours Lecturers

751-5001-00L

Agroecologists without Borders

W 2 credits 2S

C. Decock, A. Hofmann, J. Six

751-5001-00L

Tropical Soils and Land Use

W 2 credits 2G

J. Six, A. Hofmann

This seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.

Objective

(1) Students analyze concrete examples of agricultural development projects in tropical agroecosystems.
(2) Students broaden their understanding of environmental and socio-economic challenges of smallholder farmers.
(3) Students articulate complexity and challenges in agricultural development interventions.
(4) Students develop their science communication skills by producing science communication materials in the context of the given case study.

Students signing up for this class should have a strong interest in tropical agriculture and science communication.

Lectures and exercises:

(1) Introduction to international soil classification with focus on tropical soils
(2) Soil suitability (chemical, physical and biological fertility) for tropical crops
(3) Soil conservation practices and stakeholder involvement
(4) Approaches to analyzing tropical agroecosystems
(5) Overview of the major land use systems in Western Kenya
(6) Analysis of agricultural production systems
(7) Hands-on training on the use of field methods, diagnostic tools and survey methods
(8) Collaboration in international student teams (MSc students from Switzerland, Belgium and Kenya)
The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isotope into a system can be done to get some information on the structure of the system. Students will learn how human impacts on ecosystems via management or global change are mainly driven by effects on biogeochemical cycles and thus ecosystem functioning, but also about feedback mechanisms of terrestrial ecosystems. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

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The seminar concerns current aspects and research related to nutrient cycles in agro-ecosystems. It offers to deepen the knowledge on a specific theme related to nutrients. It is composed by presentations of national and international speakers and by an excursion. The students write a report where they compile the obtained information, relate it to their own knowledge and include literature.

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Objective
To gain a holistic understanding of resource-driven and regulatory processes in agricultural and natural ecosystems.
Develop skills on the critical analysis of scientific papers.
Define explanatory hypotheses, identify knowledge gaps for further investigations.
Carry out a multi-disciplinary experiment that involves aspects of soil, (micro-)biology, plant physiology, pathology, and ecology.
Develop manual skills in the set up of a glasshouse experiment, in soil and plant analyses, and in isolation and DNA-based characterisation of rhizobia.
Gain insights on basic methods to analyse (bio-)chemical, molecular genetic, and graphical data.
Discuss and interpret data in the context of the literature.
Prepare a research report in the format of a scientific paper and a poster in the format of a conference paper, partially alone and partially in small groups, using data obtained from the glasshouse experiment.

Content
This course is designed to stimulate thinking and promote critical analysis of important processes that occur in the rhizosphere. As part of this course, the knowledge acquired will be used for analysing and interpreting experimental data, as well as, preparing a scientific report and conference-type poster.

The course will cover the relative importance of spatial scales and various physicochemical and microbiological dynamics as influenced by roots. We will discuss root traits and activities that influence the immediately root-surrounding soil and thereby contribute to mineral nutrient mobilization and immobilization. An overview of the most relevant root-microbe symbioses for agroecosystems will be provided and root and microbial traits discussed, which could be of use in efforts towards utilization of intercropping and bioinoculants as a possible means of reducing energetically expensive inputs to farming systems. A special emphasis will be given to the importance of physicochemical features of soils and the chemical forms (= species) of elements important for plant uptake.

Practical experience will be gained with setting up a glasshouse experiment, soil and root sampling, basic soil and plant analyses, isolation of rhizobia, determination of the number of colony forming units (CFU), assays to screen for phosphorus and zinc solubilizing bacteria, DNA extraction, PCR amplification, and restriction fragment length polymorphism analysis (RFLP) of host range determining symbiosis-specific genes.

In short, the processes dealt with in this course occur on a small-scale and are generally (bio)chemical and microbiological in nature. Furthermore, they are generally not taken into account using current methods of agronomic management for plant production. However, they are increasingly being recognized as a potentially useful means of obtaining a resource-efficient and hence, economically and environmentally sustainable agricultural system, including for ecosystem restoration. Therefore, the course will invite for critical reflections and exemplify challenges in translating knowledge from scientific studies and ecology into application for plant production.

Lecture notes
For documentation, lecture slides and laboratory protocols will continuously be uploaded to the directory '751-5123-00L Rhizosphere Ecology' on the electronic document exchange platform ILIAS, LDA-ELBA:
Literature


How microbes can feed the world (American Academy of Microbiology) http://academy.asm.org/index.php/browse-all-reports/800-how-microbes-can-help-feed-the-world

Can microbes feed the world? (Society for general microbiology) http://www.sgm.ac.uk/en/publications/microbiology-today/past-issues.cfm/publication/can-microbes-feed-the-world

Popular science entries to the significance of processes in the rhizosphere:
http://www.the-scientist.com/?articles.view/articleNo/30950/title/The-Root-of-the-Problem/
http://www.nautil.us/issue/34/adaptation/junk-food-is-bad-for-plants-too
http://www.els.net/WileyCDA/elsArticle/refId-a0000403.html
http://www.nature.com/scitable/knowledge/library/plant-soil-interactions-nutrient-uptake-105289112
http://www.els.net/WileyCDA/elsArticle/refId-a0000403.html

Prerequisites / notice

We ask all course attendees of the agricultural sciences to have passed the exams at the end of the lectures Plant Nutrition I and II (Nutrient cycling in agroecosystems) by Prof. E. Frossard. All others, have to have successfully worked through the e-learning module Plant Nutrition I by Prof. E. Frossard. We ask all course attendees of the agricultural sciences to have passed the exams at the end of the lectures Plant Nutrition I and II (Nutrient cycling in agroecosystems) by Prof. E. Frossard. All others, have to have successfully worked through the e-learning module Plant Nutrition I by Prof. E. Frossard: https://moodle-app2.etzh.ch/course/view.php?id=279

Remark: The course is designed to be complementary to those on Radioisotopes in Plant Nutrition (751-3405-00L), and Nutrient Fluxes in Soil-Plant Systems (751-3404-00L), although some thematic overlaps cannot be avoided. Special emphasis is given to plant-microbe-soil interactions and an appreciation of whole plant functioning in the ecological context. You will familiarize yourself with bacterial isolation, cultivation, enumeration, as well as, molecular detection, discrimination and identification techniques for rhizosphere and root-associated microorganisms. Marking will consider the efforts and outcome of work by the individual participant as well as results of work in small groups. Activities for the course will result in posters and reports in the format of a conference and scientific paper. Reports will be due on Friday January 6, 2017. Maximum number of participants: 18 (Attention: Admission will be on a first come first served basis - inscribe early!). Students of D-USYS will be reimbursed via bank transfer for train and bus tickets of the zones 121 and 122 (Please send all tickets with the bank details to Christiane Gujan (http://www.plantnutrition.etzh.ch/the-group/people-a-z/person-detail.html?persid=85593).

| 751-5125-00L | Stable Isotope Ecology of Terrestrial Ecosystems | W | 2 credits | 2G | R. A. Werner, N. Buchmann, A. Gessler |

Abstract

This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to process-oriented ecological research. Topics focus on stable isotopes as indicators for the origin of pools and fluxes, partitioning of composite fluxes as well as to trace and integrate processes. In addition, students carry out a small project during lab sessions. Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know the relevant approaches, concepts and recent results in stable isotope ecology, know how to combine classical and modern techniques to solve ecophysiological or ecological problems, learn to design, carry out and interpret a small IsoProject, practice to search and analyze literature as well as to give an oral presentation.

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The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools and fluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally.

This course will provide an introduction to the applicability of stable isotopes to ecological research questions. Topics will focus on carbon (13C), nitrogen (15N), oxygen (18O) and hydrogen (2H) at natural isotope abundance and tracer levels. Lectures will be supplemented by intensive laboratory sessions, short presentations by students and computer exercises.

The course is based on fundamental knowledge about plant ecophysiology, soil science, and ecology in general. Course will be taught in English.

Objectives:
- explain links between physical processes in the vadose-zone and major societal and environmental challenges
- conduct and interpret a limited number of experimental studies
- apply modern measurement methods and analytical tools for hydrological data collection
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.

Prerequisites:
Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media;
- quantify driving forces and resulting fluxes of water, solute, and heat in soils;
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies

Course Literature:
- Handouts in lectures.
### General Crop Science

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>751-4104-00L</td>
<td>Alternative Crops</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>A. Walter, B. Büter, E. A. Pérez Torres</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Few crops dominate the crop rotations worldwide. Following the goal of an increased agricultural biodiversity, species such as buckwheat but also medicinal plants might become more important in future. The biology, physiology, stress tolerance and central aspects of the value-added chain of the above-mentioned and of other alternative crops will be depicted.</td>
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<td><strong>Objective</strong></td>
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<td>During this course, students learn to assess the potential of different minor or alternative crops compared to the dominant major crops based on their biological and agronomical features. Each student will assess and present a specific alternative crop of his or her choice based on information from scientific articles and Wikipedia. Wikipedia-entries will be generated.</td>
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</table>

| 751-4203-00L| Horticultural Science: Case Studies (HS)      | W    | 2 credits | 2G    | L. Bertschinger, J. Rösti, V. J. U. Zufferey |
|             | **Abstract**                                  |      |       |       | Lectures address 2 horticultural cropping systems and value chains, each one in 4 2h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated before. An excursion to a research site might be included. In a final colloquio, each group presents a report on their case study and their conclusions. |
|             | **Objective**                                 |      |       |       | Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy. |
|             | **Content**                                   |      |       |       | In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture. In the spring semester, the two addressed cropping systems and value chains are vegetable-production- and berry-production or glasshouse-horticulture. The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and branch into ongoing research and development projects. |
|             | **Lecture notes**                             |      |       |       | Documents handed out during the case studies. |
|             | **Literature**                                |      |       |       | As provided by the case study leaders. |
|             | **Prerequisites / notice**                    |      |       |       | The course builds on basic knowledge delivered in ‘Horticultural Crops I’ and ‘Horticultural Crops II’. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student. |

| 751-3603-00L| Current Challenges in Plant Breeding          | W    | 2 credits | 2G    | B. Studer, A. Hund, University lecturers |
|             | **Abstract**                                  |      |       |       | The seminar ‘Current challenges in plant breeding’ aims to bring together national and international experts in plant breeding to discuss current activities, latest achievements and future prospective of a selected topic/area in plant breeding. The topic this year will be: ‘Genome editing: potential and challenges for plant breeding’. |
|             | **Objective**                                 |      |       |       | The educational objectives cover both thematic competences and soft skills: Thematic competences: - Deepening of scientific knowledge in plant breeding - Critical evaluation of current challenges and new concepts in plant breeding - Promotion of collaboration and Master thesis projects with practical plant breeders Soft skills: - Independent literature research to get familiar with the selected topic - Critical evaluation and consolidation of the acquired knowledge in an interdisciplinary team - Establishment of a scientific presentation in an interdisciplinary team - Presentation and discussion of the teamwork outcome - Establishing contacts and strengthening the network to national and international plant breeders and scientist |
|             | **Content**                                   |      |       |       | Interesting topics related to plant breeding will be selected in close collaboration with the working group for plant breeding of the Swiss Society of Agronomy (SSA). For this year, the topic ‘Genome editing: potential and challenges for plant breeding’ was selected. |
|             | **Lecture notes**                             |      |       |       | Seminar abstracts |
|             | **Literature**                                |      |       |       | Peer-reviewed research articles, selected according to the selected topic/area. |
|             | **Prerequisites / notice**                    |      |       |       | Participation in the BSc course ‘Pflanzenzüchtung’ is strongly recommended, a completed course in ‘Molecular Plant Breeding’ is highly advantageous. |

| 751-5121-00L| Insect Ecology                                | W    | 2 credits | 2V    | R. R. Kariyat Ramachandran, C. De Moraes, M. Mescher |
|             | **Abstract**                                  |      |       |       | This is an introductory course in insect ecology. Students will learn about the ways in which insects interact with and adapt to their abiotic & biotic environments and their roles in diverse ecosystems. The course will entail lectures, outside readings, and critical analysis of contemporary literature. |
|             | **Objective**                                 |      |       |       | Students completing this course should become familiar with the application of ecological principles to the study of insects, as well as major areas of inquiry in this field. Highlighted topics will include insect behavior, chemical and sensory ecology, physiological responses to biotic and abiotic stressors, plant-insect interactions, community and food-web dynamics, and disease ecology. The course will emphasize insect evolution and adaptation in the context of specific interactions with other organisms and the abiotic environment. Examples from the literature incorporated into lectures will highlight the methods used to study insect ecology. |
|             | **Lecture notes**                             |      |       |       | Provided to students through ILIAS. |
|             | **Literature**                                |      |       |       | Selected required readings (peer reviewed literature, selected book chapters). Optional recommended readings with additional information. |

<table>
<thead>
<tr>
<th>751-4811-00L</th>
<th>Alien Organisms in Agriculture</th>
<th>W</th>
<th>2 credits</th>
<th>2G</th>
<th>J. Collatz, M. Meissle</th>
</tr>
</thead>
</table>

Data: 06.11.2018 12:57    Autumn Semester 2016    Page 42 of 1571
Abstract

The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g. the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.). The course will first present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. Students learn how human impacts on ecosystems via management or global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Objective

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

Content

Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

Lecture notes

Materials will be distributed during the course.

701-0263-01L Seminar in Evolutionary Ecology of Infectious Diseases

Abstract

Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.

Objective

This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

Content

A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

Lecture notes

Publications and class notes can be downloaded from a web page announced during the lecture.

Literature

Papers will be assigned and downloaded from a web page announced during the lecture.

751-5101-00L Biogeochemistry and Sustainable Management

Abstract

This course focuses on the interactions between ecology, biogeochemistry and management of agro- and forest ecosystems, thus, coupled human-environmental systems. Students learn how human impacts on ecosystems via management or global change are mainly driven by effects on biogeochemical cycles and thus ecosystem functioning, but also about feedback mechanisms of terrestrial ecosystems.

Objective

Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and forest ecosystems, be able to analyze and evaluate the various impacts of different management practices under different environmental conditions, search literature, write and evaluate scientific reports, and be able to coordinate and work successfully in small interdisciplinary teams.

Content

Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Prerequisites / literature

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

Lecture notes

Handouts will be available on the webpage of the course.

751-3405-00L Radio-Isotopes in Plant Nutrition

Abstract

The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isotope into a system can be done so as to get some information on the structure of the system. Case studies will be presented to determine element availability. From other groups will be analyzed and presented by the students.

Objective

At the end of this course the students are familiar with the principles on which radioisotope works are based and they have learned from case studies how radioisotopes can be used to obtain meaningful data. They are aware of the advantages of using radioisotopes in element cycling studies, but also of the risks and open questions related to isotope work.

Content

Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g. exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.).

The course will first present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g. number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

Lecture notes

Documents will be distributed during the lecture

Lecture notes

The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at: http://www.pe.ipw.agr.ethz.ch/about/reach

751-5125-00L Stable Isotope Ecology of Terrestrial Ecosystems

Abstract

This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to process-oriented ecological research. Topics focus on stable isotopes as indicators for the origin of pools and fluxes, partitioning of composite fluxes as well as to trace compartments. In addition, students will outline a small project during lab sessions.

Objective

Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know the relevant approaches, concepts and recent results in stable isotope ecology, know how to combine classical and modern techniques to solve ecological or ecological problems, learn to design, carry out and interpret a small IsotopeProject; practice to search and analyze literature as well as to give an oral presentation.
This course will provide an introduction to the applicability of stable isotopes to ecological research questions. Topics will focus on carbon (13C), nitrogen (15N), oxygen (18O) and hydrogen (2H) at natural isotope abundance and tracer levels. Lectures will be supplemented by intensive laboratory sessions, short presentations by students and computer exercises.

The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools and fluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally.

Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods.

Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods.

This course is based on fundamental knowledge about plant ecophysiology, soil science, and ecology in general. Course will be taught in English.

Handouts will be available on the webpage of the course.

This course does not provide the mathematical background that students are expected to bring along when signing up to this course.
Non-Ruminant Science

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<tr>
<th>Number</th>
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<tr>
<td>751-5601-00L</td>
<td>Plant Pathology III</td>
<td>W</td>
<td>2</td>
<td></td>
<td>U. Merz, M. Maurhofer Bringolf</td>
</tr>
<tr>
<td>Abstract</td>
<td>Identification based on host, symptoms and micro-morphology, completed with life cycles and related control measures of the most important fungal diseases and their causal pathogens of annual and perennial crops with agricultural significance.</td>
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<tr>
<td>Objective</td>
<td>The students will learn and train preparation skills for microscopy, acquire knowledge of selected diseases (identification, biology of pathogen, epidemiology) and understand the corresponding integrated control measures practiced in Swiss agriculture.</td>
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<tr>
<td>Content</td>
<td>The course will partly be an e-learning exercise (with computers). A script will be used on annual and perennial crops and their most important diseases. It will be updated stepwise.</td>
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<tr>
<td>Lecture notes</td>
<td>The course will be in German (spec. nomenclature).</td>
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Non-Ruminant Science

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<tr>
<td>751-6001-00L</td>
<td>Pig Science (HS)</td>
<td>W</td>
<td>3</td>
<td></td>
<td>E. Hillmann, M. C. Härdi-Landerer</td>
</tr>
<tr>
<td>Abstract</td>
<td>The overall goal of the course is to provide the essential scientific knowledge of the genetic, physiological and special nutritional aspects of pigs metabolism, animal health and behaviour, and of the implications for environment, product quality, housing and animal welfare, and breeding programs.</td>
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<tr>
<td>Objective</td>
<td>Students will understand the complex interactions of nutrition, quality traits of products, breeding and reproduction, health management, behaviour and husbandry.</td>
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<td>Content</td>
<td>Four main topics in Pig Science: HS - Behaviour and Husbandry of pigs: behavioral needs, husbandry related behavioral disorders, design and construction of housing systems in accordance with welfare requirements and legal regulations. - Planning of reproductive cycle in practice - Welfare monitoring in practice - Pigs in organic farming - Animal Health and Diseases: animal hygiene, immunology/vaccinations, metabolic diseases, diarrhoe, legislation, thermoregulation, important infections, prophylaxis. - Poster, exam and evaluation</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts/scripts are distributed by the lecturers.</td>
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<tr>
<td>Literature</td>
<td>Specific literature is indicated by the lecturers.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The lecture corresponds with the lecture &quot;Ruminant Science&quot; and knowledge in animal health, nutrition and breeding as well as applied ethology and animal welfare are recommended. The lecture usually is in German, but there is always the possibility to change to English.</td>
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Niches in Animal Production

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<tr>
<td>751-6901-00L</td>
<td>Niches in Animal Production</td>
<td>W</td>
<td>1</td>
<td></td>
<td>M. Kreuzer, M. Buchmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course deals with unconventional animals or production forms and specific aspects of for keeping them in Europe or, more specifically, in Switzerland. This includes e.g. rare breeds, wild cattle, deer, camelds, ostrich and fish. Particular emphasis will be given to the regulations and the problems occurring with import, housing and marketing of the products.</td>
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<td>Objective</td>
<td>At the end of the course the students are able to describe the conditions of keeping unconventional livestock and to develop recommendations for farmers intending to include niche production into the farm enterprise.</td>
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<tr>
<td>Content</td>
<td>The contact hour part of the course (16 h) is conceptually a block course which is subdivided into one day of lecture and one day of excursion. The non-contact hour part (14 h) is to comprehend the information given and to prepare for the examination.</td>
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<tr>
<td>Lecture notes</td>
<td>A documentation will be provided at the start of the course. Will be communicated at the start of the course.</td>
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<tr>
<td>Literature</td>
<td>Will be communicated at the start of the course.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Lecture and excursion have the same weight with respect to time allocation</td>
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Conservation of Animal Genetic Resources

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<tr>
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<th>Lecturers</th>
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<tr>
<td>751-6243-00L</td>
<td>Conservation of Animal Genetic Resources</td>
<td>W</td>
<td>1</td>
<td></td>
<td>H. Signer-Hasler, C. Flury</td>
</tr>
<tr>
<td>Abstract</td>
<td>Conservation of Animal Genetic Resources overviews the distribution, endangerment and conservation of farm animal genetic resources in Switzerland and abroad. The theory is illustrated with numerous examples and the knowledge is deepened in exercises.</td>
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<tr>
<td>Objective</td>
<td>The students will overview the distribution and endangerment of animal genetic resources on national and international level and they know, where to find the relevant information.</td>
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<tr>
<td>Content</td>
<td>- can explain, what value can be assigned to biodiversity and name reasons, why biodiversity should be conserved. - know the national and international efforts of the present and the past to conserve biodiversity in the livestock sector. - can explain what is important concerning the management of small populations. - can explain differences between species and breeds concerning biodiversity conservation. - can describe different conservation activities, in particular in situ and ex situ conservation - can describe current national and international conservation programmes for species and breeds.</td>
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Forum: Livestock in the World Food System

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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-6001-00L</td>
<td>Forum: Livestock in the World Food System</td>
<td>W</td>
<td>2</td>
<td></td>
<td>M. Kreuzer, S. Bauersachs,</td>
</tr>
</tbody>
</table>
This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.

In the Forum "Livestock in the World Food System", a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.

The Forum "Livestock in the World Food System" will take place in blocks of 2 hours each. Once the general topic has been selected, it comprises two elements:

Element 1. Oral Presentation: The students form small groups and are lecturers. There are chair persons (moderators) from outside of these small groups and they also head the discussion. The remaining students and lecturers are the audience.

Element 2. Scientific writing: Option 1: preparation of a short scientific type of paper from a result table offered by the lecturers; Option 2: preparation of an abstract with limited word count from a scientific paper; Option 3: writing of a critical review of a paper. The students have to select 2 of the three options each. There will be a discussion be a discussion in small groups at two dates.

Introductions to both forms of presentation will be offered by lecturers.

The preparation of the oral and written presentations takes place to a small part during the 2-h blocks and mainly outside of this time.

Requirements for allocation of the two credit points:
- Theatre presentation (with handout) at the forum
- Delivery of written documents of sufficient quality
- Active participation during the presentations by the other participants

The students can select 2 of the three options each. There will be a discussion be a discussion in small groups at two dates.

Practical course in Microscopy of Functional Histology

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<th>Number</th>
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<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>751-6127-00L</td>
<td>Practical course in Microscopy of Functional Histology</td>
<td>W</td>
<td>3 credits</td>
<td>6P</td>
<td>S. E. Ulbrich</td>
</tr>
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</table>

Principles of Livestock Systems

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td>751-7703-00L</td>
<td>Tropical Animal Nutrition</td>
<td>W</td>
<td>1 credit</td>
<td>1G</td>
<td>S. Marquardt</td>
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</tbody>
</table>

Farm animals play an important role in most agro/eco - systems, but conditions for a successful management and nutrition in the tropics are diverse. In this course a wide range of aspects are examined.

The aim of this course is to know and understand animal production systems in the different zones of the tropics taking into consideration the local and social structure of the population. We will deal with different aspects of animal nutrition in the tropics.

- Introduction to the tropics
- Special problems and challenges in tropical regions
- Importance of livestock in the tropics
- Animal production and livestock production systems in the tropics
- Special challenges for livestock in the tropics
- Feeds available in the tropics
- Tropical pasture systems and their characteristics
- Quality of feeds in the tropics
- Problems and challenges of animal nutrition in the tropics

Conservation of Animal Genetic Resources

Conservation of Animal Genetic Resources overviews the distribution, endangerment and conservation of farm animal genetic resources in Switzerland and abroad. The theory is illustrated with numerous examples and the knowledge is deepened in exercises.

The students

- overview the distribution and endangerment of animal genetic resources on national and international level and they know, where to find the relevant information.
- can explain, what value can be assigned to biodiversity and name reasons, why biodiversity should be conserved.
- know the national and international efforts of the present and the past to conserve biodiversity in the livestock sector.
- can explain what is important concerning the management of small populations.
- can explain differences between species and breeds concerning biodiversity conservation.
- can describe different conservation activities, in particular in situ and ex situ conservation
- can describe current national and international conservation programmes for species and breeds.

Practical Course in Molecular Physiology

This course is intended to intensify and broaden the knowledge of molecular biology gained during the bachelor lab practical course. It directly allows students to commence a master thesis with a detailed knowledge of pitfalls in experimental setup. It will also sensitize for the awareness of biological and technical variance in experimental research.

The course will be divided in two parts:

Experimental part:
- Isolation of leukocytes from blood and milk (cattle)
- Culture of isolated cells and stimulation, e.g., with LPS
- Extraction of RNA
- Quantification and quality control of RNA (Nanodrop, Fluorometer, Bioanalyzer)
- Analysis of gene expression by the use of quantitative real-time RT-PCR

Theoretical part:
- Principles of primary cell culture and transcripcional regulation, methods for analytical detection
- Bioinformatics (scientific databases, sequence analysis, biostatistics)
- Presentations by the students (e.g. techniques for analysis of physiological regulatory processes, application examples)
Content
In this practical course the students will achieve a comprehensive understanding of molecular physiology in livestock research. A cell culture experiment using blood and milk leucocytes under pathogen-associated treatment will be performed and the analysis of differential gene expression undertaken. The primary cell culture study will give insights into the laboratory work undertaken in animal physiology research. It will include the general discussion of strategies for an appropriate experimental setup in livestock research and possible methods and tools for the analysis. Hands-on cell culture and harvesting, preanalytical sample preparation and measurement implementation as well as the analysis of differential gene expression, data analysis and statistical evaluation using bioinformatics will be performed. In addition, the students will present talks based on state-of-the-art primary literature about related topics to prepare for the course and to complement the provided information. The course will enable the students to design, perform and evaluate laboratory in vitro investigations of physiological regulatory processes on a cellular level.

751-6127-00L Practical course in Microscopy of Functional Histology W 3 credits 6P S. E. Ulbrich
751-6129-00L Practical course Epigenetics W 3 credits 6P S. E. Ulbrich

Ruminant Science

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<tr>
<th>Number</th>
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<th>ECTS</th>
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Abstract
The course provides the scientific basis of the central aspects of reproduction, husbandry and nutrition physiology of ruminants, and of the implications for animal welfare, product quality, breeding programs, and organic livestock systems. Means of knowledge transfer include interdisciplinary approaches, disciplinary parts, web-based learning and self-study.

Objective
At the end of the course the students are able to apply, by a comprehensive understanding of the underlying mechanisms, their knowledge in various fields of ruminant science. They will be able to develop and recommend best strategies for breeding programs, feed formulation, improving forage quality, increasing animal health and welfare etc. They will be trained to carry out interdisciplinary and disciplinary research at the highest level. The course Ruminant Science (FS) offered in spring has a similar structure but is complementary to this course.

Content
Fields (contact hours)
- Introduction: 2 h
- Special topics: 12 h
- Lameness
- Fertility in Cows
- Food Intake of Ruminants
- Disciplinary topics: 36 h
- Ruminant Husbandry: 16 h
- Ruminant Nutrition Physiology: 10 h
- Reproduction in Ruminants: 8 h
- Lectures held by the students: 4 h

In summary
- Contact hours: 52 h
- Self-study within semester: 30 h (especially preparation for the interdisciplinary courses and the own lecture)
- Self-study in semester break: 38 h
Total: 120 h

Prerequisites / notice
The specialty of this course is that for the first time the animal science disciplines are unified. This is realised with a particular emphasis on interdisciplinary special topics and new forms of teaching. At the same time the essential basics in the central fields are communicated.

Lecture notes
Information on books and other references will be communicated during the course

Literature
Documents, links and other materials will be provided at the start of the course

Conditions for successful participation:
- Background on animal science from the Bachelor is desired. In order to attend the Minor in Ruminant Science without any animal science background, a realistic self-assessment concerning the need for additional self-study is recommended (e.g. by choosing an appropriate bachelor course which then may be counted as 'optional courses' in the master). These efforts depend on the extent to which animal science courses have already been attended in the bachelor.

- The control of performance will consist of:
  - an own lecture
  - a final oral examination with focus on comprehension of the fundamental linkages rather than of specific details

751-7211-00L Ruminal Digestion W 1 credit 1G A. Schwarm

Abstract
This course broadens the knowledge in one of the most important aspects of ruminant nutrition: the microbial digestion in the rumen (and in the hindgut). For a comprehensive understanding of the rumen microbial ecosystem, the mechanisms of nutrient fermentation and the synthesis of microbial protein, thorough basics are provided. Apart from lectures, group and laboratory exercises are included.

Objective
The course enables students to understand in detail how ruminal digestion works and how this knowledge can be applied to design optimal feeding diets using highly fibrous forages and a variety of other feeds. The students also are able to show how to modify the most important rumen microbes beneficially by nutritional means.
Content

Structure of the contact hour part of the course (14 h):

2 h Introduction and blackboard exercise

8 h Basic topics in ruminal digestion, lectures and group exercises:
- Systematics of the microbes involved in microbial digestion
- Measurement of microbial digestion
- Interactions of microbes and epithelium of the digestive tract
- Differences between ruminal and hindgut microbial digestion
- Microbial nutrient degradation and its modification
- Efficiency of microbial protein synthesis
- Manipulation of the ruminal digestion

2 h Laboratory exercise with a rumen fistulated cow and the Rumen Simulation Technique

2 h Final seminar

Lecture notes

The non-contact hour part is to comprehend the information given and to prepare either the written report or the oral presentation (cf. "Besonderes")

Literature

Lecture notes are provided via Moodle.

Prerequisites / notice

The course is a balanced mixture of blackboard exercise, laboratory exercise, group exercise, lecture and student seminar presentation.

Credit point associated with grade of either a written report or an oral presentation in the final seminar (both on a self-chosen related topic)

751-6001-00L Forum: Livestock in the World Food System W 2 credits 1S M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neuenschwander

Abstract

This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.

Objective

In the Forum "Livestock in the World Food System", a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.

Content

The Forum "Livestock in the World Food System" will take place in blocks of 2 hours each. Once the general topic has been selected, it comprises two elements:

Element 1. Oral Presentation: The students form small groups and are lecturers. There are chair persons (moderators) from outside of these small groups and they also head the discussion. The remaining students and lecturers are the audience.

Element 2. Scientific writing: Option 1: preparation of a short scientific type of paper from a result table offered by the lecturers; Option 2: preparation of an abstract with limited word count from a scientific paper; Option 3: writing of a critical review of a paper. The students have to select 2 of the three options each. There will be a discussion be a discussion in small groups at two dates.

Introductions to both forms of presentation will be offered by lecturers.

The preparation of the oral and written presentations takes place to a small part during the 2-h blocks and mainly outside of this time.

Lecture notes

no scriptum

Prerequisites / notice

Requirements for allocation of the two credit points:
- Theatre presentation (with handout) at the forum
- Delivery of written documents of sufficient quality
- Active participation during the presentations by the other participants

Safety and Quality in Agri-Food Chain

Number Title Type ECTS Hours Lecturers

751-6001-00L Forum: Livestock in the World Food System W 2 credits 1S M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neuenschwander

Abstract

This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.

Objective

In the Forum "Livestock in the World Food System", a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.

Content

The Forum "Livestock in the World Food System" will take place in blocks of 2 hours each. Once the general topic has been selected, it comprises two elements:

Element 1. Oral Presentation: The students form small groups and are lecturers. There are chair persons (moderators) from outside of these small groups and they also head the discussion. The remaining students and lecturers are the audience.

Element 2. Scientific writing: Option 1: preparation of a short scientific type of paper from a result table offered by the lecturers; Option 2: preparation of an abstract with limited word count from a scientific paper; Option 3: writing of a critical review of a paper. The students have to select 2 of the three options each. There will be a discussion be a discussion in small groups at two dates.

Introductions to both forms of presentation will be offered by lecturers.

The preparation of the oral and written presentations takes place to a small part during the 2-h blocks and mainly outside of this time.

Lecture notes

no scriptum

Prerequisites / notice

Requirements for allocation of the two credit points:
- Theatre presentation (with handout) at the forum
- Delivery of written documents of sufficient quality
- Active participation during the presentations by the other participants

751-4203-00L Horticultural Science: Case Studies (HS) W 2 credits 2G L. Bertschinger, J. Rösti, V. J. U. Zufferey

Abstract

Lectures address 2 horticultural cropping systems and value chains, each one in 4 2h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated before. An excursion to a research site might be included. In a final colloquium, each group presents a report on their case study and their conclusions.

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 48 of 1571
<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>701-1543-00L</td>
<td>Transdisciplinary Methods and Applications</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. Krütli, M. Stauffacher</td>
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<tr>
<td>752-111-00L</td>
<td>Gene Technology in Foods</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>L. Meile</td>
</tr>
<tr>
<td>752-2307-00L</td>
<td>Nutritional Aspects of Food Composition and Processing</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>B. E. Baumer, J. M. Sych</td>
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<tr>
<td>751-0021-00L</td>
<td>World Food System Summer School</td>
<td>W</td>
<td>4</td>
<td>6P</td>
<td>N. Buchmann</td>
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Objective
Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.

Content
In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture. In the spring semester, the two addressed cropping systems and value chains are vegetable-production- and berry-production or glasshouse-horticulture. The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and branch into ongoing research and development projects.

Lecture notes
Documents handed out during the case studies.

Literature
As provided by the case study leaders.

Prerequisites / notice
The course builds on basic knowledge delivered in 'Horticultural Crops I' and 'Horticultural Crops II'. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student.

Language: spoken E, G or F, Documents: Preferably English, G/F possible.

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<td>752-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Siegrist, C. Hartmann</td>
</tr>
<tr>
<td>752-2307-00L</td>
<td>Nutritional Aspects of Food Composition and Processing</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>B. E. Baumer, J. M. Sych</td>
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Objective
This course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g. nutritional profile) will be addressed. The course will provide knowledge about food composition and detection technologies in food; food safety assessment of GMO food; information on the legislation in Switzerland and European countries.

Content
Lecture notes
Copies of slides from lectures will be provided.

Literature
Actual publications from literature will be provided.

Prerequisites / notice
Good knowledge in microbiology and molecular biology are prerequisites. Some contents will be provided by registered students who will individually or as a group present an actual publication.

Language: spoken E, G or F, Documents: Preferably English, G/F possible.

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Abstract
Lecture type course with an interdisciplinary approach for the evaluation of nutritional aspects of changes in food composition due to processing.

Objective
Students should be able to - describe and compare the major concepts/criteria used for the evaluation of the nutritional quality of food - apply these criteria when assessing the effects of selected processing technologies on nutritional quality.

Content
The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g. nutritional profile) will be addressed. There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course.

Lecture notes
The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and branch into ongoing research and development projects.

Literature
Documents handed out during the case studies.

Prerequisites / notice
The course builds on basic knowledge delivered in 'Horticultural Crops I' and 'Horticultural Crops II'. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student.

Language: spoken E, G or F, Documents: Preferably English, G/F possible.

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 49 of 1571
Abstract
The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines. Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

Objective
At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2017

Content
The lecture is structured as follows:

- Overview of concepts and methods of inter-/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

Lecture notes
Handouts are provided by the lecturers

Literature
Selected scientific articles and book-chapters

Prerequisites / notice
This course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.
Content

Fields (contact hours)
- Introduction: 2 h
- Special topics: 12 h
  - Lamelessness
  - Fertility in Cows
  - Food Intake of Ruminants
- Disciplinary topics: 36 h
  - Ruminant Husbandry: 16 h
  - Ruminant Nutrition Physiology: 10 h
  - Reproduction in Ruminants: 8 h
- Lectures held by the students: 4 h

In summary
- Contact hours: 52 h
- Self-study within semester: 30 h (especially preparation for the interdisciplinary courses and the own lecture)
- Self-study in semester break: 38 h
Total: 120 h

Lecture notes

Documents, links and other materials will be provided at the start of the course

Literature

Information on books and other references will be communicated during the course

Prerequisites / notice

The specialty of this course is that for the first time the animal science disciplines are unified. This is realised with a particular emphasis on interdisciplinary special topics and new forms of teaching. At the same time the essential basics in the central fields are communicated.

The field of Ruminant Science will also be a part of the spring semester (special topics: Organic Ruminant Systems, Tropical Ruminant Systems, Mastitis; disciplinary courses: Cattle, Sheep and Goat Breeding, Ruminant Diseases and Prophylaxis, Ruminant Nutrition and the Environment). However both courses are organized independently.

Conditions for successful participation: Background on animal science from the Bachelor is desired. In order to attend the Minor in Ruminant Science without any animal science background, a realistic self-assessment concerning the need for additional self-study is recommended (e.g. by choosing an appropriate bachelor course which then may be counted as ‘optional courses’ in the master). These efforts depend on the extent to which animal science courses have already been attended in the bachelor.

The control of performance will consist of:
- an own lecture
- a final oral examination with focus on comprehension of the fundamental linkages rather than of specific details

751-7211-00L

Ruminal Digestion

Abstract

This course broadens the knowledge in one of the most important aspects of ruminant nutrition: the microbial digestion in the rumen (and in the hindgut). For a comprehensive understanding of the rumen microbial ecosystem, the mechanisms of nutrient fermentation and the synthesis of microbial protein, thorough basics are provided. Apart from lectures, group and laboratory exercises are included.

Objective

The course enables students to understand in detail how ruminal digestion works and how this knowledge can be applied to design optimal feeding diets using highly fibrous forages and a variety of other feeds. The students also are able to show how to modify the most important rumen microbes beneficially by nutritional means.

Content

Structure of the contact hour part of the course (14 h):

2 h Introduction and blackboard exercise
8 h Basic topics in ruminal digestion, lectures and group exercises:
  - Systematics of the microbes involved in microbial digestion
  - Measurement of microbial digestion
  - Interactions of microbes and epithelium of the digestive tract
  - Differences between ruminal and hindgut microbial digestion
  - Microbial nutrient degradation and its modification
  - Efficiency of microbial protein synthesis
  - Manipulation of the ruminal digestion

2 h Laboratory exercise with a rumen fistulated cow and the Rumen Simulation Technique
2 h Final seminar

The non-contact hour part is to comprehend the information given and to prepare either the written report or the oral presentation (cf. “Besonderes”)

Lecture notes

Lecture notes are provided via Moodle.

Literature

Will be communicated at the start of the course.

Prerequisites / notice

The course is a balanced mixture of blackboard exercise, laboratory exercise, group exercise, lecture and student seminar presentation.

Credit point associated with grade of either a written report or an oral presentation in the final seminar (both on a self-chosen related topic)
This course deals with unconventional animals or production forms and specific aspects of keeping them in Europe or, more specifically, in Switzerland. This includes, e.g., rare breeds, wild cattle, deer, camelids, ostrich, and fish. Particular emphasis will be given to the local and social structure of the population. We will deal with different aspects of animal nutrition in the tropics.

- Behaviour and Husbandry of pigs: behavioral needs, husbandry related behavioral disorders, design and construction of housing systems in accordance with welfare requirements and legal regulations.
- Planning of reproductive cycle in practice
- Welfare monitoring in practice
- Pigs in organic farming
- Animal Health and Diseases: animal hygiene, immunology/vaccinations, metabolic diseases, diarrhoe, legislation, thermoregulation, important infections, prophylaxis.
- Poster, exam and evaluation

This introductory session will be followed by a series of lectures that provide an overview of tropical animal nutrition, including:

- Special Physiology of Pig Nutrition: food intake; growth; metabolism and digestion at different growth stages; energy and specific nutritional requirements; feeding systems; environmental aspects, efed.
- Genetics: Breeding systems, reproductive techniques, performance tests and recording, etc.
- Oral presentation, exam, evaluation

The lecture corresponds with the lecture “Ruminant Science” and knowledge in animal health, nutrition and breeding as well as applied ethology and animal welfare are recommended. The lecture usually is in German, but there is always the possibility to change to English.

### Livestock in the World Food System

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
751-6001-00L | Forum: Livestock in the World Food System | W+ | 2 credits | 1S | M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neuenschwander

**Abstract**
This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.

**Objective**
In the Forum “Livestock in the World Food System”, a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.

**Content**
The Forum “Livestock in the World Food System” will take place in blocks of 2 hours each. Once the general topic has been selected, it comprises two elements:

Element 1. Oral Presentation: The students form small groups and are lecturers. There are chair persons (moderators) from outside of these small groups and they also head the discussion. The remaining students and lecturers are the audience.

Element 2. Scientific writing: Option 1: preparation of a short scientific type of paper from a result table offered by the lecturers; Option 2: preparation of an abstract with limited word count from a scientific paper; Option 3: writing of a critical review of a paper. The students have to select 2 of the three options each. There will be a discussion be a discussion in small groups at two dates.

Introductions to both forms of presentation will be offered by lecturers. The preparation of the oral and written presentations takes place to a small part during the 2-h blocks and mainly outside of this time.

**Lecture notes**
no scriptum

**Prerequisites / notice**
Requirements for allocation of the two credit points:
- Theatre presentation (with handout) at the forum
- Delivery of written documents of sufficient quality
- Active participation during the presentations by the other participants

751-7703-00L | Tropical Animal Nutrition | W+ | 1 credit | 1G | S. Marquardt

**Abstract**
Farm animals play an important role in most agro/eco - systems, but conditions for a successful management and nutrition in the tropics are diverse. In this course a wide range of aspects are examined.

**Objective**
The aim of this course is to know and understand animal production systems in the different zones of the tropics taking into consideration the local and social structure of the population. We will deal with different aspects of animal nutrition in the tropics.

**Content**
- Introduction to the tropics
- Special problems and challenges in tropical regions
- Importance of livestock in the tropics
- Animal production and livestock production systems in the tropics
- Special challenges for livestock in the tropics
- Feeds available in the tropics
- Tropical pasture systems and their characteristics
- Quality of feeds in the tropics
- Problems and challenges of animal nutrition in the tropics

751-6901-00L | Niches in Animal Production | W+ | 1 credit | 1G | M. Kreuzer, M. Buchmann

**Abstract**
This course deals with unconventional animals or production forms and specific aspects of keeping them in Europe or, more specifically, in Switzerland. This includes, e.g., rare breeds, wild cattle, deer, camelids, ostrich, and fish. Particular emphasis will be given to the regulations and the problems occurring with import, housing and marketing of the products.

**Objective**
At the end of the course the students are able to describe the conditions of keeping unconventional livestock and to develop recommendations for farmers intending to include niche production into the farm enterprise.

**Content**
The contact hour part of the course (16 h) is conceptually a block course which is subdivided into one day of lecture and one day of excursion.

**Lecture notes**
The non-contact hour part (14 h) is to comprehend the information given and to prepare for the examination

**Lecture and excursion have the same weight with respect to time allocation**

### Animal Health and Genetics

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
751-6900-00L | Animal Health and Genetics | | | | M. Kreuzer, M. Buchmann

**Abstract**
A documentation will be provided at the start of the course.

**Objective**
Will be communicated at the start of the course.

**Content**
Lecture and excursion have the same weight with respect to time allocation.
751-6305-00L  Livestock Breeding and Genomics  W+  3 credits  3G  P. von Rohr

Abstract  Methods for analysing livestock data, in particular for the estimation of breeding values: principles of selection index, introduction to BLUP, application of common models used, relationship matrix, methods for the estimation of variance components, basics of breeding programs. The material will be illustrated via exercises and assignments.

Objective  The students are able to set up design matrices, the relationship matrix and its inverse as well as the Mixed Model equations to estimate BLUP breeding values for smaller examples.

Content  - Selection index (various sources of information, one trait, multiple traits)
- Relationship matrix and its inverse
- BLUP: one trait, repeated observations, multiple traits, economic indices
- Introduction to methods for the estimation of variance components
- Assignments

Lecture notes  Copies of the slides are available on the net.

Literature  To be announced in the lectures.

751-6243-00L  Conservation of Animal Genetic Resources  W+  1 credit  1V  H. Signer-Hasler, C. Flury

Abstract  Conservation of Animal Genetic Resources overviews the distribution, endangerment and conservation of farm animal genetic resources in Switzerland and abroad. The theory is illustrated with numerous examples and the knowledge is deepened in exercises.

Objective  The students
- overview the distribution and endangerment of animal genetic resources on national and international level and they know, where to find the relevant information.
- can explain, what value can be assigned to biodiversity and name reasons, why biodiversity should be conserved.
- know the national and international efforts of the present and the past to conserve biodiversity in the livestock sector.
- can explain what is important concerning the management of small populations.
- can explain differences between species and breeds concerning biodiversity conservation.
- can describe different conservation activities, in particular in situ and ex situ conservation
- can describe current national and international conservation programmes for species and breeds.

751-6113-00L  Endocrinology and Biology of Reproduction  W+  3 credits  2V  S. E. Ulbrich

Abstract  Endokrinologie und Reproduktionsbiologie der Säugetiere und des Menschen (Anatomie, Morphologie, Physiologie, Regelmechanismen) Die Systematik der Reproduktionshormone und der Hormonrezeptoren wird erläutert, die Wirkungsmechanismen (Bildung; orale Bioverfügbarkeit; Elimination) erklärt. Mit diesen Grundlagen wird das Verständnis der Regulation der Fortpflanzung umfassend erörtert.

Objective  Die Studierenden erlangen das grundlegende theoretische Verständnis und Fachwissen zur Endokrinologie der Reproduktion und zur weiblichen und männlichen Reproduktionsbiologie. Sie können darüber hinaus pathologische Situationen (Fortpflanzungsstörungen) und deren vielfältige Ursachen in den physiologischen Kontext einordnen.

Methodology Competences
Methods in Animal Science

Number  Title  Type ECTS  Hours  Lecturers
751-6241-00L  Laboratory Practical in Molecular Animal Genetics and Inherited Diseases  W+  3 credits  3P  S. Neuenschwander, A. Bratus-Neuenschwander, C. Schelling

Abstract  Technologies of molecular animal-, immuno- and biochemical genetics will be shown and applied to selected domestic and farm animals. The students will perform laboratory tests for genome analysis (identification of gene loci, gene mapping); gene expression (mRNA, proteins), diagnostics (analysis of hereditary diseases) and verification of animals and animal products (parentage control, forensics).

Objective  Get to know and apply the basic laboratory methods to systematically identify loci controlling important performance and disease traits and analysis of the molecular nature of variation at the loci. At the end of the course the students are able to understand the underlying mechanisms influencing genetic variations and to analyze gene variants in the laboratory. The students know the importance of the technologies for animal breeding, animal health and quality of animal products in Switzerland and internationally. The material is illustrated on practical examples.

Content  - Introduction to the course (aims, program, written examination)
- Porcine E.coli test. Determination of the mutation in FUT1
- Sequencing of DNA
- Marker-/microsatellite analyses
- Forensics
- Cytogenetics
- Cell cultures
- Inheritance of coat colour
- Gene expression and animal biotechnology

Contact hours: 42 h
Self-study (preparation for courses and examination): additionally
Handouts/scripts will be distributed by the lecturers.

751-6003-00L  Training Course in Research Groups (Large)  W+  6 credits  13P  M. Kreuzer, E. Hillmann, S. Neuenschwander, S. E. Ulbrich

Abstract  The students will learn the conceptual and methodological background of research in the animal science groups of the Institute of Plant, Animal and Agroecosystem Science. In addition to teaching the theoretical background, the major aim of the course is to integrate the students into the research groups (on job training) and, hence, to focus on the practical application of the knowledge.

Objective  - Introduction into the conceptual and methodological basis of research
- Integration of the students into the research groups (on job training)
- Application of the gained knowledge

Content  The students will be integrated into the research groups day-to-day work and will thus deal with all aspects of scientific work. This comprises the planning (conceptually and logistically), execution (data collection, laboratory analyses) and evaluation (statistics, data presentation) of experiments as well as the basics of scientific writing (aim: later publication, Master thesis). The research topics and the range of methodologies vary between the animal science research groups in the Institute of Plant, Animal and Agroecosystem Sciences.
In this course, different experimental designs will be discussed and various statistical tools will be applied to research questions in molecular physiology. The course will be divided in two parts: Experimental Design and Applied Statistics in agroecosystem science, and Training Course in Research Groups (Small). The full integration in a research group often means to work on weekends. The total time budget is equivalent to about 180 hours. Active participation in group meetings (discussion, presentation) and short written reports about the work conducted are required for the 6 credit points. There are no grades, it is only pass or fail.

### Course Program

#### Experimental Design and Applied Statistics in agroecosystem science

- **Abstract:** Students will learn the conceptual and methodological background of research in the animal science groups of the Institute of Plant, Animal and Agroecosystem Science. In addition to teaching the theoretical background, the major aim of the course is to integrate the students into the research groups (on job training) and, hence, to focus on the practical application of the knowledge.
- **Objectives:**
  - Introduction into the conceptual and methodological basis of research
  - Integration of the students into the research groups (on job training)
  - Application of the gained knowledge
- **Content:** The students will be integrated into the research groups day-to-day work and will thus deal with all aspects of scientific work. This comprises the planning (conceptually and logistically), execution (data collection, laboratory analyses) and evaluation (statistics, data presentation) of experiments as well as the basics of scientific writing (aim: later publication, Master thesis). The research topics and the range of methodologies vary between the animal science research groups in the Institute of Plant, Animal and Agroecosystem Sciences.

#### Training Course in Research Groups (Small)

- **Abstract:** The number of training slots in the various groups is limited. It is therefore highly recommended to contact the group leaders early enough (first come first serve).
- **Objectives:**
  - Selection of basic techniques and methods to analyse data using a hands-on approach. Methods range from simple t-tests to multi-factorial analysis.
  - This course does not provide the mathematical background that students are expected to bring along when signing up to this course.
  - Students will know various statistical analyses and their application to science problems in their study area as well as a wide range of experimental design options used in environmental and agricultural sciences. They will practice to use statistical software packages (R), understand pros and cons of various designs and statistics, and be able to statistically evaluate their own results as well as those of published studies.
- **Content:** The course program uses a learning-by-doing approach ("hands-on minds-on"). New topics are introduced in the lecture hall, but most of the work is done in the computer lab to allow for the different speeds of progress of the student while working with data and analyzing results. In addition to contact hours exercises must be finalized and handed in for grading. The credit points will be given based on successful assessments of selected exercises.

The tentative schedule contains the following topics:

- Introduction To Experimental Design and Applied Statistics
- Introduction to 'R' / Revival of 'R' Skills
- Nonlinear Regression Fits
- Multivariate Techniques: Principle Component Analysis, Canonical Correpondence Analysis (CCA), Cluster Analysis
- ANOVA using linear and mixed effect models
- Error Analysis, Error Propagation and Error Estimation
- Introduction to autoregression and autocorrelations in temporal and spatial data and how to consider them in ANOVA-type analysis
- This course does not provide the mathematical background that students are expected to bring along when signing up to this course. Alternatively, students can consider some aspects of this course as a first exposure to solutions in experimental design and applied statistics and then deepen their understanding in follow-up statistical courses.

#### Practical course in Microscopy of Functional Histology

- **Abstract:** The course is based on the course Mathematik IV: Statistik, passed in the 2nd year and the Bachelor’s course "Wissenschaftliche Datenauswertung und Datenpräsentation" (751-0441-00L). The full integration in a research group often means to work on weekends. The total time budget is equivalent to about 90 hours. Active participation in group meetings (discussion, presentation) and short written reports about the work conducted are required for the 3 credit points. There are no grades, it is only pass or fail.
- **Objectives:** Students will learn the conceptual and methodological background of research in the animal science groups of the Institute of Plant, Animal and Agroecosystem Science. They will practice to use statistical software packages (R), understand pros and cons of various designs and statistics, and be able to statistically evaluate their own results as well as those of published studies.
- **Content:** The course program uses a learning-by-doing approach ("hands-on minds-on"). New topics are introduced in the lecture hall, but most of the work is done in the computer lab to allow for the different speeds of progress of the student while working with data and analyzing results. In addition to contact hours exercises must be finalized and handed in for grading. The credit points will be given based on successful assessments of selected exercises.

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- Introduction to autoregression and autocorrelations in temporal and spatial data and how to consider them in ANOVA-type analysis
- This course does not provide the mathematical background that students are expected to bring along when signing up to this course. Alternatively, students can consider some aspects of this course as a first exposure to solutions in experimental design and applied statistics and then deepen their understanding in follow-up statistical courses.

#### Practical course in Epigenetics

- **Abstract:** The course is based on the course Mathematik IV: Statistik, passed in the 2nd year and the Bachelor’s course "Wissenschaftliche Datenauswertung und Datenpräsentation" (751-0441-00L). The full integration in a research group often means to work on weekends. The total time budget is equivalent to about 90 hours. Active participation in group meetings (discussion, presentation) and short written reports about the work conducted are required for the 3 credit points. There are no grades, it is only pass or fail.
- **Objectives:** Students will learn the conceptual and methodological background of research in the animal science groups of the Institute of Plant, Animal and Agroecosystem Science. They will practice to use statistical software packages (R), understand pros and cons of various designs and statistics, and be able to statistically evaluate their own results as well as those of published studies.
- **Content:** The course program uses a learning-by-doing approach ("hands-on minds-on"). New topics are introduced in the lecture hall, but most of the work is done in the computer lab to allow for the different speeds of progress of the student while working with data and analyzing results. In addition to contact hours exercises must be finalized and handed in for grading. The credit points will be given based on successful assessments of selected exercises.

The tentative schedule contains the following topics:

- Introduction To Experimental Design and Applied Statistics
- Introduction to 'R' / Revival of 'R' Skills
- Nonlinear Regression Fits
- Multivariate Techniques: Principle Component Analysis, Canonical Correpondence Analysis (CCA), Cluster Analysis
- ANOVA using linear and mixed effect models
- Error Analysis, Error Propagation and Error Estimation
- Introduction to autoregression and autocorrelations in temporal and spatial data and how to consider them in ANOVA-type analysis
- This course does not provide the mathematical background that students are expected to bring along when signing up to this course. Alternatively, students can consider some aspects of this course as a first exposure to solutions in experimental design and applied statistics and then deepen their understanding in follow-up statistical courses.

#### Practical Course in Molecular Physiology

- **Abstract:** This course is intended to intensify and broaden the knowledge of molecular biology gained during the bachelor lab practical course. It directly allows students to commence a master thesis with a detailed knowledge of pitfalls in experimental setup. It will also sensitize for the awareness of biological and technical variance in experimental research.
- **Objectives:**
  - The course will be divided into two parts:
    - Experimental part:
      - Isolation of leukocytes from blood and milk (cattle)
      - Culture of isolated cells and stimulation, e.g., with LPS
      - Extraction of RNA
      - Quantification and quality control of RNA (Nanodrop, Fluorometer, Bioanalyzer)
      - Analysis of gene expression by the use of quantitative real-time RT-PCR
    - Theoretical part:
      - Principles of primary cell culture and transcriptional regulation, methods for analytical detection
      - Bioinformatics (scientific databases, sequence analysis, biostatistics)
      - Presentations by the students (e.g. techniques for analysis of physiological regulatory processes, application examples)
In this practical course the students will achieve a comprehensive understanding of molecular physiology in livestock research. A cell culture experiment using blood and milk leukocytes under pathogen-associated treatment will be performed and the analysis of differential gene expression undertaken. The primary cell culture study will give insights into the laboratory work undertaken in animal physiology research. It will include the general discussion of strategies for an appropriate experimental setup in livestock research and possible methods and tools for the analysis. Hands-on cell culture and harvesting, preanalytical sample preparation and measurement implementation as well as the analysis of differential gene expression, data analysis and statistical evaluation using bioinformatics will be performed. In addition, the students will present talks based on state-of-the-art primary literature about related topics to prepare for the course and to complement the provided information. The course will enable the students to design, perform and evaluate laboratory in vitro investigations of physiological regulatory processes on a cellular level.

### Major in Crop Science

#### Disciplinary Competences

#### Cropping Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>751-4203-00L</td>
<td>Horticultural Science: Case Studies (HS)</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>L. Bertschinger, J. Rösti, V. J. U. Zufferey</td>
</tr>
</tbody>
</table>

#### Abstract

Lectures address 2 horticultural cropping systems and value chains, each one in 4 2h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated before. An excursion to a research site might be included. In a final colloquium, each group presents a report on their case study and their conclusions.

#### Objective

Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.

#### Content

In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture. In the spring semester, the two addressed cropping systems and value chains are vegetable-production and berry-production or glasshouse-horticulture.

The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and branch into ongoing research and development projects.

#### Lecture notes

Documents handed out during the case studies.

#### Literature

As provided by the case study leaders.

#### Prerequisites / notice

The course builds on basic knowledge delivered in ‘Horticultural Crops I’ and ‘Horticultural Crops II’. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student.

Language: spoken E, G or F, Documents: Preferably English, G/F possible.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-4104-00L</td>
<td>Alternative Crops</td>
<td>W+</td>
<td>2</td>
<td>2V</td>
<td>A. Walter, B. Büter, E. A. Pérez Torres</td>
</tr>
</tbody>
</table>

#### Abstract

Few crops dominate the crop rotations worldwide. Following the goal of an increased agricultural biodiversity, species such as buckwheat but also medicinal plants might become more important in future. The biology, physiology, stress tolerance and central aspects of the value-added chain of the above-mentioned and of other alternative crops will be depicted.

#### Objective

During this course, students learn to assess the potential of different minor or alternative crops compared to the dominant major crops based on their biological and agronomical features. Each student will assess and present a specific alternative crop of his or her choice based on information from scientific articles and Wikipedia. Wikipedia-entries will be generated.

### Crop Health
Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for regulation (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

Students completing this course should become familiar with the application of ecological principles to the study of insects, as well as major areas of inquiry in this field. Highlighted topics will include insect behavior, chemical and sensory ecology, physiological responses to biotic and abiotic stressors, plant-insect interactions, community and food-web dynamics, and disease ecology. The course will emphasize insect evolution and adaptation in the context of specific interactions with other organisms and the abiotic environment. Examples from the literature incorporated into lectures will highlight the methods used to study insect ecology.

Seminar in Evolutionary Ecology of Infectious Diseases

Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.

This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

Students will understand the consequences arising from the unintentional or deliberate introduction of alien organisms into agricultural systems. They will be able to understand the concept of environmental risk assessment and be able to evaluate risk management options.

Alien organisms in agriculture is a topic that receives an increasing awareness among farmers, agricultural scientists, regulators and the general public. Students of this course will learn about the nature of alien organisms such as invasive species, biocontrol organisms and genetically modified organisms. With a particular focus on arthropods, plants and their interactions we will look at the potential threats the novel organisms pose, the benefits they provide and how both of these effects can be scientifically assessed. Students will learn how the topic of alien organisms in agriculture is intrinsically tied to policy making and regulation and get to know current examples and future challenges in research. In the last part of the course students will be able to apply the acquired knowledge in a practical exercise (case study).

The course focuses on alien organisms in agriculture as well as the scientific assessment and regulatory management of their effects on the environment and agricultural production.

The seminar concerns current aspects and research related to nutrient cycles in agro-ecosystems. It offers to deepen the knowledge on a specific theme related to nutrients. It is composed by presentations of national and international speakers and by an excursion. The students write a report where they compile the obtained information, relate it to their own knowledge and include literature.

The complex interactions of a coupled human-environmental system.

Handouts will be available on the webpage of the course. Will be discussed in class.

Prerequisites: Attendance of introductory courses in plant ecophysiology, ecology, and grassland or forest sciences. Course will be taught in English.

Students will understand the complex interactions of a coupled human-environmental system. They will be able to understand the concept of environmental risk assessment and be able to evaluate risk management options.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

The seminar concerns current aspects and research related to nutrient cycles in agro-ecosystems. It offers to deepen the knowledge on a specific theme related to nutrients. It is composed by presentations of national and international speakers and by an excursion. The students write a report where they compile the obtained information, relate it to their own knowledge and include literature.

Listen and understand expert's presentations. Ask questions and contribute to the discussion during the talk sessions and the excursion.

Link the information obtained during the seminar with knowledge from previous lessons and with literature searched to complement the matter. Expand the knowledge on nutrient cycles and nutrient management in the agro-ecosystem.

Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.
The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of radioisotopes can be used to obtain meaningful data. They are aware of the advantages of using radioisotopes in element cycling studies, but also of the risks and open questions related to isotope work. The course will partly be an e-learning exercise (with computers).

Recent Advances in Biocommunication

Identifications based on host, symptoms and micro-morphology, completed with life cycles and related control measures of the most important fungal diseases and their causal pathogens of annual and perennial crops with agricultural significance.

The students will learn and train preparation skills for microscopy, acquire knowledge of selected diseases (identification, biology of pathogen, epidemiology) and understand the corresponding integrated control measures practiced in Swiss agriculture.

The course will partly be an e-learning exercise (with computers).

The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isotope into a system can be done to get some information on the structure of the system. Case studies will be presented to determine element availability. Finally, published studies from other groups will be analyzed and presented by the students.

At the end of this course the students are familiar with the principles on which radioisotope works are based and they have learned from case studies how radioisotopes can be used to obtain meaningful data. They are aware of the advantages of using radioisotopes in element cycling studies, but also of the risks and open questions related to isotope work.
Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g., exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.). The course will first present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g., number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

Content

Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g., exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.). The course will first present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g., number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

Lecture notes

Documents will be distributed during the lecture

Literature

Will be given during the lecture

Prerequisites / notice

The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at: http://www.pe.ipw.agrl.ethz.ch/about/reach

751-5123-00L Rhizosphere Ecology

Number of participants limited to 18.

Prerequisites: Only students who have passed the courses 751-3401-00L Pflanzenernährung I and 751-3402-00L Pflanzenernährung II - Integriertes Nährstoffmanagement can be admitted to this course.

Abstract

This course is about the physical, chemical, and biological processes in the rhizosphere and their effect on plant growth. Effects of fertilisers, companion plants, and microbial symbionts, and other microbes on nutrient cycling and plant uptake are discussed. An "intercropping" experiment in the glasshouse is used as a model to check for rhizosphere effects on plant growth and mineral nutrition.

Objective

To gain a holistic understanding of resource-driven and regulatory processes in agricultural and natural ecosystems.

Develop skills on the critical analysis of scientific papers.

Define explanatory hypotheses, identify knowledge gaps for further investigations.

Carry out a multi-disciplinary experiment that involves aspects of soil, (micro-)biology, plant physiology, pathology, and ecology.

Develop manual skills in the set up of a glasshouse experiment, in soil and plant analyses, and in isolation and DNA-based characterisation of rhizobia.

Gain insights on basic methods to analyse (bio-)chemical, molecular genetic, and graphical data.

Discuss and interpret data in the context of the literature.

Prepare a research report in the format of a scientific paper and a poster in the format of a conference paper, partially alone and partially in small groups, using data obtained from the glasshouse experiment.

Content

This course is designed to stimulate thinking and promote critical analysis of important processes that occur in the rhizosphere. As part of this course, the knowledge acquired will be used for analysing and interpreting experimental data, as well as, preparing a scientific report and conference-type poster.

The course will cover the relative importance of spatial scales and various physicochemical and microbiological dynamics as influenced by roots. We will discuss root traits and activities that influence the immediately root-surrounding soil and thereby contribute to mineral nutrient mobilization and immobilization. An overview of the most relevant root-microbe symbioses for agroecosystems will be provided and root and microbial traits discussed, which could be of use in efforts towards utilization of intercropping and bioinoculants as a possible means of reducing energetically expensive inputs to farming systems. A special emphasis will be given to the importance of physicochemical features of soils and the chemical forms (= species) of elements important for plant uptake.

Practical experience will be gained with setting up a glasshouse experiment, soil and root sampling, basic soil and plant analyses, isolation of rhizobia, determination of the number of colony forming units (CFU), assays to screen for phosphorus and zinc solubilizing bacteria, DNA extraction, PCR amplification, and restriction fragment length polymorphism analysis (RFLP) of host range determining symbiosis-specific genes.

In short, the processes dealt with in this course occur on a small-scale and are generally (bio)chemical and microbiological in nature. Furthermore, they are generally not taken into account using current methods of agronomic management for plant production. However, they are increasingly being recognized as a potentially useful means of obtaining a resource-efficient and hence, economically and environmentally sustainable agricultural system, including for ecosystem restoration. Therefore, the course will invite for critical reflections and exemplify challenges in translating knowledge from scientific studies and ecology into application for plant production.

Lecture notes

For documentation, lecture slides and laboratory protocols will continuously be uploaded to the directory ‘751-5123-00L Rhizosphere Ecology’ on the electronic document exchange platform ILIAS, LDA-ELBA: https://ilias-app21.let.ethz.ch/ilias.php?ref_id=109651&cmd=view&cmdClass=ilobjcoursegui&cmdNode=ef:tv&baseClass=ilRepositoryGUI
This course provides an overview about the applicability of stable isotopes (carbon $^{13}$C, nitrogen $^{15}$N, oxygen $^{18}$O and water $^{2}$H) to

Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know

R. A. Werner

Stable Isotope Ecology of Terrestrial Ecosystems

N. Buchmann,


How microbes can feed the world (American Academy of Microbiology) http://academy.asm.org/index.php/browse-all-reports/800-how-microbes-can-help-feed-the-world

Can microbes feed the world? (Society for general microbiology) http://www.sgm.ac.uk/en/publications/microbiology-today/past-issues.cfm/publication/can-microbes-feed-the-world

Popular science entries to the significance of processes in the rhizosphere:

http://www.the-scientist.com/?articles.view/articleNo/30950/title/The-Root-of-the-Problem/


http://nautil.us/issue/34/adaptation/junk-food-is-bad-for-plants-too

Ecological understanding (Second Edition)


How microbes can feed the world (American Academy of Microbiology) http://academy.asm.org/index.php/browse-all-reports/800-how-microbes-can-help-feed-the-world

Can microbes feed the world? (Society for general microbiology) http://www.sgm.ac.uk/en/publications/microbiology-today/past-issues.cfm/publication/can-microbes-feed-the-world

Popular science entries to the significance of processes in the rhizosphere:

http://www.the-scientist.com/?articles.view/articleNo/30950/title/The-Root-of-the-Problem/


http://nautil.us/issue/34/adaptation/junk-food-is-bad-for-plants-too

Ecological understanding (Second Edition)


We ask all course attendees of the agricultural sciences to have passed the exams at the end of the lectures Plant Nutrition I and II (Nutrient cycling in agroecosystems) by Prof. E. Frossard. All others, have to have successfully worked through the e-learning module Plant Nutrition I by Prof. E. Frossard. All others, have to have successfully worked through the e-learning module Plant Nutrition I by Prof. E. Frossard: https://moodle-app2.let.ethz.ch/course/view.php?id=279

Remark: The course is designed to be complementary to those on Radioisotopes in Plant Nutrition (751-3405-00L), and Nutrient Fluxes in Soil-Plant Systems (751-3404-00L), although some thematic overlaps cannot be avoided. Special emphasis is given to plant-microbe-soil interactions and an appreciation of whole plant functioning in the ecological context. You will familiarize yourself with bacterial isolation, cultivation, enumeration, as well as, molecular detection, discrimination and identification techniques for rhizosphere and root-associated microorganisms.

Marking will consider the efforts and outcome of work by the individual participant as well as results of work in small groups. Activities for the course will result in posters and reports in the format of a conference and scientific paper. Reports will be due on Friday January 6, 2017.

Maximum number of participants: 18 (Attention: Admission will be on a first come first served basis - inscribe early!).

Students of D-USYS will be reimbursed via bank transfer for train and bus tickets of the zones 121 and 122 (Please send all tickets with the bank details to Christiane Gujan (http://www.plantnutrition.ethz.ch/the-group/people-a-z/person-detail.html?persid=85593).

751-5125-00L Stable Isotope Ecology of Terrestrial Ecosystems W+ 2 credits 2G R. A. Werner, N. Buchmann, A. Gessler

Abstract

This course provides an overview about the applicability of stable isotopes (carbon $^{13}$C, nitrogen $^{15}$N, oxygen $^{18}$O and water $^{2}$H) to process-oriented ecological research. Topics focus on stable isotopes as indicators for the origin of pools and fluxes, partitioning of composite fluxes as well as to trace and integrate processes. In addition, students carry out a small project during lab sessions.

Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know the relevant approaches, concepts and recent results in stable isotope ecology, know how to combine classical and modern techniques to solve ecophysiological or ecological problems, learn to design, carry out and interpret a small IsoProject, practice to search and analyze literature as well as to give an oral presentation.

Data: 06.11.2018 12:57

Autumn Semester 2016

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The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools and fluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally.

This course will provide an introduction to the applicability of stable isotopes to ecological research questions. Topics will focus on carbon (13C), nitrogen (15N), oxygen (18O) and hydrogen (2H) at natural isotope abundance and tracer levels. Lectures will be supplemented by intensive laboratory sessions, short presentations by students and computer exercises.

Content

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 60 of 1571
- Introduction IO
  o Relevant topics for the food sector
  o high competition and market saturation
  o low R&D intensity
  o bargaining power of retailers
  o Private label introduction
- Theoretical Approaches
  o Structure Conduct Performance
  o Market Based View
  o Porter's Five Forces
  o Resource Based View
  o Knowledge Based View
  o Empirical Issues (Based on published research papers)
  o Competition / Concentration
  o Profitability
  o Impact of Innovation / R&D
  o Efficiency
  o Market power
  o Econometric Approaches

Literature
Several theoretical and empirical IO related research papers

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<tr>
<th>752-2122-00L</th>
<th>Food and Consumer Behaviour</th>
<th>W+</th>
<th>2 credits</th>
<th>2V</th>
<th>M. Siegrist, C. Hartmann</th>
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<tr>
<td>Abstract</td>
<td>This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.</td>
<td></td>
<td></td>
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<tr>
<td>Objective</td>
<td>The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues</td>
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<table>
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<tr>
<th>751-2205-00L</th>
<th>Advanced Management in the Agri-Food-Chain</th>
<th>W+</th>
<th>2 credits</th>
<th>2G</th>
<th>M. Weber</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>Advanced Management in the Agri-Food-Chain (Vorlesung wird in deutscher Sprache abgehalten.)</td>
<td></td>
<td></td>
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<tr>
<td>Objective</td>
<td>After the lecture the students ...</td>
<td></td>
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<td></td>
<td>... know the characteristics and consequences of complexity in the organizational world.</td>
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<td></td>
<td>... know and can apply selected comprehensive models for managing in complex situations,</td>
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<td></td>
<td>... know possible practical applications and examples of the treated contents to organizations in the Agri-Food Chain and</td>
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<td></td>
<td>... are able to deepen the relevant topics in an autonomous way.</td>
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<table>
<thead>
<tr>
<th>363-0403-00L</th>
<th>Introduction to Marketing</th>
<th>W+</th>
<th>3 credits</th>
<th>2G</th>
<th>F. von Wangenheim</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The course is designed to convey a profound understanding of marketing's role in modern firms, its interactions and interfaces with other disciplines, its main instruments and recent trends. Particular attention is given to emerging marketing concepts and instruments, and the role of marketing in technology firms.</td>
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<tr>
<td>Objective</td>
<td>After taking the lecture, students should have knowledge on</td>
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<tr>
<td></td>
<td>1) The definition and role of marketing (marketing basics)</td>
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<td></td>
<td>2) Creating marketing insights - understanding customer behavior</td>
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<td></td>
<td>- Theoretical concepts in customer behavior (customer behavior)</td>
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<td></td>
<td>- Analytical means to extend knowledge on customer behavior (marketing research)</td>
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<td></td>
<td>- Strategic tools to quantify customer behavior (CLV, CE)</td>
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<td></td>
<td>3) Strategic marketing - translating marketing insights into actionable marketing strategies</td>
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<td></td>
<td>- Segmentation, Targeting, and Positioning</td>
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<td></td>
<td>- Attracting customers (marketing mix, 4Ps)</td>
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<td></td>
<td>- Maintaining profitable customer relations (CRM)</td>
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</table>

<table>
<thead>
<tr>
<th>701-1651-00L</th>
<th>Environmental Governance</th>
<th>W+</th>
<th>3 credits</th>
<th>2G</th>
<th>E. Lieberherr, G. de Buren, R. Schweizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Environmental Governance</td>
<td></td>
<td></td>
<td></td>
<td>E. Lieberherr, G. de Buren, R. Schweizer</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course addresses environmental policies, focusing on new steering approaches, which are generally summarized as environmental governance. The course also provides students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.</td>
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</table>

Environmental and Resource Use Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1651-00L</td>
<td>Environmental Governance</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>E. Lieberherr, G. de Buren, R. Schweizer</td>
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<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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</tbody>
</table>

Autumn Semester 2016

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

Content

Improvements in environmental and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of 'environmental governance' and how legitimate and effective are these approaches in addressing persistent environmental challenges?

Lecture notes

Lecture slides and additional course material will be provided throughout the semester.

Prerequisites / notice

A detailed course schedule will be made available at the beginning of the semester.

We recommend that students have (a) three-years BSc education of a (technical) university; (b) successfully completed Bachelor introductory course to environmental policy (Entwicklungsgesetze der internationalen Umweltpolitik (or equivalent)) and (c) familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy).

851-0594-00L International Environmental Politics

W 3 credits 2V T. Bernauer

Particularly suitable for students of D-ITET, D-USYS

Abstract

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

Objective

The main part of this lecture will examine constellations where hierarchies, markets or cooperation have been observed and described in the agricultural sector. On a more aggregated level, different agricultural systems will be evaluated in terms of main socioeconomic parameters like social capital or perceptions.

Content

Groups, identities and utility maximization - some conceptual foundations
Micro-Socioeconomics: Hierarchy, cooperation and markets
Macro-Socioeconomics: Varieties of Capitalism
Agricultural Administration: Path dependencies and efficiency issues
Causes and Impacts of farm succession
Occupational Choice in the farming sector
System Choice and segregation (organic, GMO etc.)
The economics of rural areas
Common Resource Management in Alpine Farming
Agricultural Cooperatives
Societal perceptions of agriculture
Perceptions of farming from within
Value creation in agricultural systems and policies

Prerequisites / notice

Basic economic knowledge is expected.

851-2103-00L Socioeconomics of Agriculture

W+ 2 credits 2V S. Mann

Abstract

The main part of this lecture will examine constellations where hierarchies, markets or cooperation have been observed and described in the agricultural sector. On a more aggregated level, different agricultural systems will be evaluated in terms of main socioeconomic parameters like social capital or perceptions.

Objective

Students should be able to describe the dynamics of hierarchies, markets and cooperation in an agricultural context.

Content

Group identities and social utility maximization - some conceptual foundations
Micro- and macro-socioeconomics: hierarchy, cooperation and markets
Agricultural Administration: path dependencies and efficiency issues
Causes and Impacts of farm succession
Occupational Choice in the farming sector
System Choice and segregation (organic, GMO etc.)
The economics of rural areas
Common Resource Management in Alpine Farming
Agricultural Cooperatives
Societal perception of agriculture
Perceptions of farming from within
Value creation in agricultural systems and policies

Prerequisites / notice

A detailed course schedule will be made available at the beginning of the semester.

We recommend that students have (a) three-years BSc education of a (technical) university; (b) successfully completed Bachelor introductory course to environmental policy (Entwicklungsgesetze der internationalen Umweltpolitik (or equivalent)) and (c) familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy).

Autumn Semester 2016
The course gives economic and empirical foundations for a sound understanding of the instruments, prospects and limitations of international development aid. Articles and book abstracts will be uploaded to a course website.

The course focuses on agricultural economic research with particular focus on policy evaluation. We impart insights in the issue of policy evaluation as part of agricultural economics research.

I. Günther

Prerequisites / notice

The tentative schedule contains the following topics:

- Introduction To Experimental Design and Applied Statistics
- Introduction to ‘R’ / Revival of ‘R’ Skills
- Designs of Field and Growth Chamber Experiments
- Nonlinear Regression Fits
- Multivariate Techniques: Principle Component Analysis, Canonical Correpondence Analysis (CCA), Cluster Analysis
- ANOVA using linear and mixed effect models

This course does not provide the mathematical background that students are expected to bring along when signing up to this course. Alternatively, students can consider some aspects of this course as a first exposure to solutions in experimental design and applied statistics and then deepen their understanding in follow-up statistical courses.

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 63 of 1571
A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics

Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.

This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

This course is for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.
To understand how an environmental problem may (not) become a policy and explain political processes, using basic concepts and fundamental data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.

Abstract
- Ability to formulate research questions and designing an appropriate study
- Ability to collect and analyze data using a variety of methods
- Ability to critically assess the quality of empirical research in management
- Applied knowledge of empirical methods through out-of-class assignments

Content
1) Introduction to empirical management research
2) Research designs: exploratory, descriptive, experimental
3) Measurement and scaling
4) Data collection and sampling
5) Data analysis methods
6) Reporting and presenting empirical research

Prerequisites / notice
Assignments and projects: This course includes out-of-class assignments and projects to give students hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. Students will have at least one week to work on each assignment. Students are expected to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned-in on time.

Class participation: Class participation is encouraged and can greatly improve students' learning in this class. In this spirit, students are expected to attend class regularly and come to class prepared.

Intermediate Econometrics
- Applied knowledge of empirical methods through out-of-class assignments
- Ability to critically assess the quality of empirical research in management
- Ability to collect and analyze data using a variety of methods

Number of participants limited to 30.

To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of 'environmental governance' and how legitimate and effective are these approaches in addressing persistent environmental challenges?

Lecture notes
Lecture slides and additional course material will be provided throughout the semester.

Literature
The course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products. This course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

**Objective**

**Content**

01: Introduction in the issue of policy evaluation
02: The normative frame for policy evaluation
03: Evaluation of public policies
04: Context and use of evaluations
05: Quantitative policy evaluation
06: Qualitative policy evaluation
07: Group work
08: Agricultural Economics Research at ART
09: Agricultural Economics Research at FiBL
10: Examination, Feedback

**Literature**


**Prerequisites / notice**

- Students signing up for this class should have a strong interest in tropical agriculture and science communication.
- Students are able to deepen the relevant topics in an autonomous way.
- Students know possible practical applications and examples of the treated contents to organizations in the Agri-Food Chain and are able to conduct evaluations and critically reflect evaluation results.
Crop Health Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-4500-00L</td>
<td>Plant Pathology III</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>U. Merz, M. Maurhofer Bringolf</td>
</tr>
<tr>
<td>Abstract</td>
<td>Identification based on host, symptoms and micro-morphology, completed with life cycles and related control measures of the most important fungal diseases and their causal pathogens of annual and perennial crops with agricultural significance.</td>
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<tr>
<td>Objective</td>
<td>The students will learn and train preparation skills for microscopy, acquire knowledge of selected diseases (identification, biology of pathogen, epidemiology) and understand the corresponding integrated control measures practiced in Swiss agriculture.</td>
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<tr>
<td>Content</td>
<td>The course will partly be an e-learning exercise (with computers).</td>
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<tr>
<td>Lecture notes</td>
<td>A script will be used on annual and perennial crops and their most important diseases. It will be updated stepwise.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course will be in German (spec. nomenclature)</td>
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</table>

| 751-4800-00L | Recent Advances in Biocommunication              | W+   | 2    | 2S    | C. De Moraes                     |
| Number of participants limited to 25 |
| Abstract     | Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods. |
| Objective    | Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods. Students will engage in discussion and critical analyses of relevant papers and present their evaluations in a seminar setting. |
| Lecture notes| Provided to students through ILIAS. |
| Literature   | Selected required readings (peer reviewed literature, selected book chapters). Optional recommended readings with additional information. |

| 701-0263-01L | Seminar in Evolutionary Ecology of Infectious Diseases | W | 3 | 2G | D. Croll, S. Bonhoeffer, R. R. Regös |
| Abstract     | Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field. |
| Objective    | This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases. |
| Content      | A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans. |
| Lecture notes| Publications and class notes can be downloaded from the web page announced during the lecture. |
| Literature   | Papers will be assigned and downloaded from a web page announced during the lecture. |

| 751-4811-00L | Alien Organisms in Agriculture                  | W  | 2  | 2G   | J. Collatz, M. Meissle           |
| Abstract     | The course focuses on alien organisms in agriculture as well as the scientific assessment and regulatory management of their effects on the environment and agricultural production. |
| Objective    | Students will understand the consequences arising from the unintentional or deliberate introduction of alien organisms into agricultural systems. They will be able to understand the concept of environmental risk assessment and be able to evaluate risk management options. |
Alien organisms in agriculture is a topic that receives an increasing awareness among farmers, agricultural scientists, regulators and the general public. Students of this course will learn about the nature of alien organisms such as invasive species, biocontrol organisms and genetically modified organisms. With a particular focus on arthropods, plants and their interactions we will look at the potential threats the novel organisms pose, the benefits they provide and how both of these effects can be scientifically assessed. Students will learn how the topic of alien organisms in agriculture is intrinsically tied to policy making and regulation and get to know current examples and future challenges in research. In the last part of the course students will be able to apply the acquired knowledge in a practical exercise (case study).

Environmental Crop Physiology

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-3405-00L</td>
<td>Radio-Isotopes in Plant Nutrition</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>E. Frossard</td>
</tr>
<tr>
<td>751-4003-01L</td>
<td>Current Topics in Grassland Sciences (HS)</td>
<td>W+</td>
<td>2</td>
<td>2S</td>
<td>N. Buchmann</td>
</tr>
<tr>
<td>751-4104-00L</td>
<td>Alternative Crops</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>A. Walter, B. Büter, E. A. Pérez Torres</td>
</tr>
<tr>
<td>751-4203-00L</td>
<td>Horticultural Science: Case Studies (HS)</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>L. Bertschinger, J. Rösti, V. J. U. Zufferey</td>
</tr>
</tbody>
</table>

Notes:
- Lecture notes: Material will be distributed during the course.
- Literature: Documents handed out during the case studies.
- Prerequisites / notice: Students signing up for this class should have a strong interest in tropical agriculture and science communication.
**751-5101-00L Biogeochemistry and Sustainable Management**  
**W**  
2 credits  
N. Buchmann, L. Hörtnagl

**Abstract**  
This course focuses on the interactions between ecology, biogeochemistry and management of agro- and forest ecosystems, thus, coupled human-environmental systems. Students learn how human impacts on ecosystems via management or global change are mainly driven by effects on biogeochemical cycles and thus ecosystem functioning, but also about feedback mechanisms of terrestrial ecosystems.

**Objective**  
Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and forest ecosystems, be able to analyze and evaluate the various impacts of different management practices under different environmental conditions, search literature, write and evaluate scientific reports, and be able to coordinate and work successfully in small (interdisciplinary) teams.

**Content**  
Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

**Prerequisites / notice**  

**Lecture notes**  
Will be discussed in class.

**Literature**  
Handouts will be available on the webpage of the course.

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**751-5115-00L Current Aspects of Nutrient Cycle in Agro-Ecosystems**  
**W**  
2 credits  
1S  
E. Frossard, A. Oberson Dräyer

**Abstract**  
The seminar concerns current aspects and research related to nutrient cycles in agro-ecosystems. It offers to deepen the knowledge on a specific theme related to nutrients. It is composed by presentations of national and international speakers and by an excursion. The students write a report where they compile the obtained information, relate it to their own knowledge and include literature.

**Objective**  
Listen and understand expert's presentations. Ask questions and contribute to the discussion during the talk sessions and the excursion. Link the information obtained during the seminar with knowledge from previous lessons and with literature searched to complement the matter. Expand the knowledge on nutrient cycles and nutrient management in the agro-ecosystem.

**Content**  
Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

**Prerequisites / notice**  

**Lecture notes**  
Will be discussed in class.

**Literature**  
Handouts will be available on the webpage of the course.

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**751-5123-00L Rhizosphere Ecology**  
**W**  
4 credits  
4G  
H. A. Gamper, T. I. McLaren

**Abstract**  
This course is designed to stimulate thinking and promote critical analysis of important processes that occur in the rhizosphere. As part of this course, the knowledge acquired will be used for analysing and interpreting experimental data, as well as, preparing a scientific report and conference-type poster.

**Objective**  
To gain a holistic understanding of resource-driven and regulatory processes in agricultural and natural ecosystems. Develop skills on the critical analysis of scientific papers. Carry out a multi-disciplinary experiment that involves aspects of soil, (micro-)biology, plant physiology, pathology, and ecology. Develop manual skills in the set up of a glasshouse experiment, in soil and plant analyses, and in isolation and DNA-based characterisation of rhizobia. Gain insights on basic methods to analyse (bio-)chemical, molecular genetic, and graphical data. Discuss and interpret data in the context of the literature. Prepare a research report in the format of a scientific paper and a poster in the format of a conference paper, partially alone and partially in small groups, using data obtained from the glasshouse experiment.

**Content**  
The course will cover the relative importance of spatial scales and various physicochemical and microbiological dynamics as influenced by roots. We will discuss root traits and activities that influence the immediately root-surrounding soil and thereby contribute to mineral nutrient mobilization and immobilization. An overview of the most relevant root-microbe symbioses for agroecosystems will be provided and root and microbial traits discussed, which could be of use in efforts towards utilization of intercropping and bioinoculants as a possible means of reducing energetically expensive inputs to farming systems. A special emphasis will be given to the importance of physicochemical features of soils and the chemical forms (= species) of elements important for plant uptake.

**Practical experience**  
Practical experience will be gained with setting up a glasshouse experiment, soil and root sampling, basic soil and plant analyses, isolation of rhizobia, determination of the number of colony forming units (CFU), assays to screen for phosphorus and zinc solubilizing bacteria, DNA extraction, PCR amplification, and restriction fragment length polymorphism analysis (RFLP) of host range determining symbiosis-specific genes.

**Lecture notes**  
For documentation, lecture slides and laboratory protocols will continuously be uploaded to the directory ’751-5123-00L Rhizosphere Ecology’ on the electronic document exchange platform ILIAS, LDA-ELBA: https://ilias-app2.let.ethz.ch/ilias.php?ref_id=109651&cmd=view&cmdClass=llobjcoursegui&cmdNode=el:fv&baseClass=ilRepositoryGUI

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**Prerequisites / notice**  

**Language:** spoken E, G or F, Documents: Preferably English, G/F possible.
This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to solve ecophysiological or ecological problems, learn to design, carry out and interpret a small IsoProject, practice to search and analyze the relevant approaches, concepts and recent results in stable isotope ecology, know how to combine classical and modern techniques to composite fluxes as well as to trace and integrate processes. In addition, students carry out a small project during lab sessions.

We ask all course attendees of the agricultural sciences to have passed the exams at the end of the lectures Plant Nutrition I and II (Nutrient cycling in agroecosystems) by Prof. E. Frossard. All others, have to have successfully worked through the e-learning module Plant Nutrition I by Prof. E. Frossard. All others, have to have successfully worked through the e-learning module Plant Nutrition I by Prof. E. Frossard. To help with this, we created a Moodle course below. You can take the course at your own pace and check your progress regularly.

The course will result in posters and reports in the format of a conference and scientific paper. Reports will be due on Friday January 6, 2017. Marking will consider the efforts and outcome of work by the individual participant as well as results of work in small groups. Activities for the course will result in posters and reports in the format of a conference and scientific paper. Reports will be due on Friday January 6, 2017.

Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know the relevant approaches, concepts and recent results in stable isotope ecology, know how to combine classical and modern techniques to solve ecophysiological or ecological problems, learn to design, carry out and interpret a small IsoProject, practice to search and analyze literature as well as to give an oral presentation.
Content

The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools and fluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally.

This course will provide an introduction to the applicability of stable isotopes to ecological research questions. Topics will focus on carbon (13C), nitrogen (15N), oxygen (18O) and hydrogen (2H) at natural isotope abundance and tracer levels. Lectures will be supplemented by intensive laboratory sessions, short presentations by students and computer exercises.

Lecture notes

Handouts will be available on the webpage of the course.

Literature

Will be discussed in class.

Prerequisites / notice

This course is based on fundamental knowledge about plant ecophysiology, soil science, and ecology in general. Course will be taught in English.

751-3603-00L Current Challenges in Plant Breeding

Number of participants limited to 15.

Abstract

The seminar 'Current challenges in plant breeding' aims to bring together national and international experts in plant breeding to discuss current activities, latest achievements and future prospective of a selected topic/area in plant breeding.

The topic this year will be: 'Genome editing: potential and challenges for plant breeding'.

Objective

The educational objectives cover both thematic competences and soft skills:

- Deepening of scientific knowledge in plant breeding
- Critical evaluation of current challenges and new concepts in plant breeding
- Promotion of collaboration and Master thesis projects with practical plant breeders
- Soft skills:
  - Independent literature research to get familiar with the selected topic
  - Critical evaluation and consolidation of the acquired knowledge in an interdisciplinary team
  - Establishment of a scientific presentation in an interdisciplinary team
  - Presentation and discussion of the teamwork outcome
  - Establishing contacts and strengthening the network to national and international plant breeders and scientist

Content

Interesting topics related to plant breeding will be selected in close collaboration with the working group for plant breeding of the Swiss Society of Agronomy (SSA). For this year, the topic 'Genome editing: potential and challenges for plant breeding' was selected.

In the fall semester (November 29, 2016), the enrolled students will meet with the lecturers as well as four to six tutors, selected according to their expertise in the selected topic (one afternoon, for about three hours). After an input talk by the lecturers, four to six specific questions/aspects will be identified and phrased. The tutors and the enrolled students will be assigned to four to six different groups, to critically evaluate one question/aspect of the selected topic. The students, guided by tutors, will prepare a presentation of 15 minutes (plus 5 minutes discussion) covering their specific question/aspect. Participation on that afternoon will be mandatory.

End of January (January 31, 2017), a one-day seminar on the selected topic will be organized. After one to two keynote speakers (international experts), four invited talks will link the selected topic to practical plant breeding. In the afternoon, the four to six student groups will present and discuss with the experts their specific questions on the selected topic/area. These presentations will be evaluated by the lecturers. The seminar will be public and serve as annual meeting of the SSA working group for plant breeding, bringing together the experts in plant breeding.

The course is designed for a maximum of 15 Master students and 10 PhD students (advertised and recruited via the Zurich-Basel Plant Science Center). For full and active participation, a total of 2 credit/ECTS points will be provided.

Lecture notes

Seminar abstracts

Literature

Peer-reviewed research articles, selected according to the selected topic/area.

Prerequisites / notice

Participation in the BSc course ‘Pflanzenzüchtung’ is strongly recommended, a completed course in ‘Molecular Plant Breeding’ is highly advantageous.

751-5001-00L Agroecologists without Borders

Abstract

In this seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.

Objective

(1) Students analyze concrete examples of agricultural development projects in tropical agroecosystems.
(2) Students broaden their understanding of environmental and socio-economic challenges of smallholder farmers.
(3) Students articulate complexity and challenges in agricultural development interventions.
(4) Students develop their science communication skills by producing science communication materials in the context of the given case study.

Prerequisites / notice

Students signing up for this class should have a strong interest in tropical agriculture and science communication.

Functioning of Soil Systems

Table

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>701-0533-00L</td>
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<td>Soil Chemistry</td>
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<td>2G</td>
<td>R. Kretzschmar, D. I. Christl</td>
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Abstract

This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.

Objective

Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, mobility) of nutrients and pollutants.

Content

Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.

Lecture notes

Handouts in lectures.

Literature


701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology

Abstract

The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.
Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media
- Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
- Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.
- Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.
- Midterm exam
- Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
- Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.
- Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)
http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Additional textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

**751-5101-00L Biogeochemistry and Sustainable Management**

- **Objective**
  Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and forest ecosystems, be able to analyze and evaluate the various impacts of different management practices under different environmental conditions, search literature, write and evaluate scientific reports, and be able to coordinate and work successfully in small (interdisciplinary) teams.

- **Content**
  Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

  Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

- **Lecture notes**
  Handouts will be available on the webpage of the course.

- **Literature**
  Will be discussed in class.

- **Prerequisites / notice**
  Prerequisites: Attendance of introductory courses in plant ecophysiology, ecology, and grassland or forest sciences. Course will be taught in English.

**751-5115-00L Current Aspects of Nutrient Cycle in Agro-Ecosystems**

- **Objective**
  Students are able to:
  - characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
  - quantify driving forces and resulting fluxes of water, solute, and heat in soils.
  - apply modern measurement methods and analytical tools for hydrological data collection
  - conduct and interpret a limited number of experimental studies
  - explain links between physical processes in the vadose-zone and major societal and environmental challenges

- **Content**
  Weeks 1 to 3: Physical Properties of Soils and Other Porous Media
  - Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

  Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

  Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

  Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

  Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
  - Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.
  - Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.
  - Midterm exam
  - Part 3 - Use of Hydrus model for simulation of unsaturated flow

  Additional topics:
  - Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.
  - Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

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  http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

  Additional textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

- **Lecture notes**
  Will be discussed in class.

- **Literature**
  Prerequisites: Attendance of introductory courses in plant ecophysiology, ecology, and grassland or forest sciences. Course will be taught in English.
Abstract
The seminar concerns current aspects and research related to nutrient cycles in agro-ecosystems. It offers to deepen the knowledge on a specific theme related to nutrients. It is composed by presentations of national and international speakers and by an excursion. The students write a report where they compile the obtained information, relate it to their own knowledge and include literature.

Objective
Listen and understand expert's presentations. Ask questions and contribute to the discussion during the talk sessions and the excursion. Link the information obtained during the seminar with knowledge from previous lessons and with literature searched to complement the matter. Expand the knowledge on nutrient cycles and nutrient management in the agro-ecosystem.

751-5123-00L Rhizosphere Ecology
W+ 4 credits 4G H. A. Gamper, T. I. McLaren
Number of participants limited to 18.

Prerequisites: Only students who have passed the courses 751-3401-00L Pflanzenernährung I and 751-3402-00L Pflanzenernährung II - Integriertes Nährstoffmanagement can be admitted to this course.

Abstract
This course is about the physical, chemical, and biological processes in the rhizosphere and their effect on plant growth. Effects of fertilisers, companion plants, and microbial symbionts, and other microbes on nutrient cycling and plant uptake are discussed. An "intercropping" experiment in the glasshouse is used as a model to check for rhizosphere effects on plant growth and mineral nutrition.

Objective
To gain a holistic understanding of resource-driven and regulatory processes in agricultural and natural ecosystems.

Develop skills on the critical analysis of scientific papers.

Define explanatory hypotheses, identify knowledge gaps for further investigations.

Carry out a multi-disciplinary experiment that involves aspects of soil, (micro-)biology, plant physiology, pathology, and ecology.

Develop manual skills in the setup of a glasshouse experiment, in soil and plant analyses, and in isolation and DNA-based characterisation of rhizobia.

Gain insights on basic methods to analyse (bio-)chemical, molecular genetic, and graphical data.

Discuss and interpret data in the context of the literature.

Prepare a research report in the format of a scientific paper and a poster in the format of a conference paper, partially alone and partially in small groups, using data obtained from the glasshouse experiment.

Content
This course is designed to stimulate thinking and promote critical analysis of important processes that occur in the rhizosphere. As part of this course, the knowledge acquired will be used for analysing and interpreting experimental data, as well as, preparing a scientific report and conference-type poster.

The course will cover the relative importance of spatial scales and various physicochemical and microbiological dynamics as influenced by roots. We will discuss root traits and activities that influence the immediately root-surrounding soil and thereby contribute to mineral nutrient mobilization and immobilization. An overview of the most relevant root-microbe symbioses for agroecosystems will be provided and root and microbial traits discussed, which could be of use in efforts towards utilization of intercropping and bioinoculants as a possible means of reducing energetically expensive inputs to farming systems. A special emphasis will be given to the importance of physicochemical features of soils and the chemical forms (= species) of elements important for plant uptake.

Practical experience will be gained with setting up a glasshouse experiment, soil and root sampling, basic soil and plant analyses, isolation of rhizobia, determination of the number of colony forming units (CFU), assays to screen for phosphorus and zinc solubilizing bacteria, DNA extraction, PCR amplification, and restriction fragment length polymorphism analysis (RFLP) of host range determining symbiosis-specific genes.

In short, the processes dealt with in this course occur on a small-scale and are generally (bio)chemical and microbiological in nature. Furthermore, they are generally not taken into account using current methods of agronomic management for plant production. However, they are increasingly being recognized as a potentially useful means of obtaining a resource-efficient and hence, economically and environmentally sustainable agricultural system, including for ecosystem restoration. Therefore, the course will invite for critical reflections and exemplify challenges in translating knowledge from scientific studies and ecology into application for plant production.

Lecture notes
For documentation, lecture slides and laboratory protocols will continuously be uploaded to the directory '751-5123-00L Rhizosphere Ecology' on the electronic document exchange platform ILIAS, LDA-ELBA: https://ilias-app2.let.ethz.ch/ilias.php?ref_id=109651&cmd=view&cmdClass=ilobjcoursegui&cmdNode=el:tv&baseClass=ilRepositoryGUI
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The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools and fluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally.

This course will provide an introduction to the applicability of stable isotopes to ecological research questions. Topics will focus on carbon (13C), nitrogen (15N), oxygen (18O) and hydrogen (2H) at natural isotope abundance and tracer levels. Lectures will be supplemented by intensive laboratory sessions, short presentations by students and computer exercises.

Lecture notes
Documents will be distributed during the lecture

Prerequisites / notice
Students students signing up for this class should have a strong interest in tropical agriculture and science communication.

Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g. exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.).

The course will first present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools and fluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally.

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Documents will be distributed during the lecture

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Students students signing up for this class should have a strong interest in tropical agriculture and science communication.
Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.

In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture.

The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and branch into ongoing research and development projects.

As provided by the case study leaders.

The course builds on basic knowledge delivered in 'Horticultural Crops I' and 'Horticultural Crops II'. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student.

Language: spoken E, G or F, Documents: Preferably English, G/F possible.

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The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and branch into ongoing research and development projects.

As provided by the case study leaders.

The course builds on basic knowledge delivered in 'Horticultural Crops I' and 'Horticultural Crops II'. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student.

Language: spoken E, G or F, Documents: Preferably English, G/F possible.

Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.

In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture.

The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and branch into ongoing research and development projects.

As provided by the case study leaders.

The course builds on basic knowledge delivered in 'Horticultural Crops I' and 'Horticultural Crops II'. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student.

Language: spoken E, G or F, Documents: Preferably English, G/F possible.
<table>
<thead>
<tr>
<th>Lecture notes / notice</th>
<th>Livestock Breeding and Genomics</th>
<th>3 credits</th>
<th>3G</th>
<th>P. von Rohr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>The students are able to set up design matrices, the relationship matrix and its inverse as well as the Mixed Model equations to estimate BLUP breeding values for smaller examples.</td>
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<tr>
<td>Content</td>
<td>Selection index (various sources of information, one trait, multiple traits)</td>
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<td></td>
<td>Relationship matrix and its inverse</td>
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<td></td>
<td>BLUP: one trait, repeated observations, multiple traits, economic indices</td>
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<td></td>
<td>Introduction to methods for the estimation of variance components</td>
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<td>Assignments</td>
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<tr>
<td>Literature</td>
<td>Copies of the slides are available on the net.</td>
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<table>
<thead>
<tr>
<th>Lecture notes / notice</th>
<th>Pig Science (HS)</th>
<th>3 credits</th>
<th>3V</th>
<th>E. Hillmann, M. C. Härdi-Landerer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>The overall goal of the course is to provide the essential scientific knowledge of the genetic, physiological and special nutritional aspects of pigs, metabolism, animal health and behaviour, and of the implications for environment, product quality, housing and animal welfare, and breeding programs.</td>
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<tr>
<td>Content</td>
<td>Students will</td>
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<td></td>
<td>- understand the complex interactions of nutrition, quality traits of products, breeding and reproduction, health management, behaviour and husbandry.</td>
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<td></td>
<td>- be trained to understand interdisciplinary and disciplinary research.</td>
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<td>- be able to critically analyze published research data.</td>
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<td></td>
<td>- be able to present precise scientific reports in oral and written form.</td>
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<tr>
<td>Literature</td>
<td>Handouts/scripts are distributed by the the lecturers.</td>
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<tr>
<th>Lecture notes / notice</th>
<th>Tropical Animal Nutrition</th>
<th>1 credit</th>
<th>1G</th>
<th>S. Marquardt</th>
</tr>
</thead>
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<tr>
<td>Objective</td>
<td>The aim of this course is to know and understand animal production systems in the different zones of the tropics taking into consideration the local and social structure of the population. We will deal with different aspects of animal nutrition in the tropics.</td>
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<tr>
<td>Content</td>
<td>- Introduction to the tropics</td>
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<td></td>
<td>- Special problems and challenges in tropical regions</td>
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<td>- Importance of livestock in the tropics</td>
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<tr>
<td></td>
<td>- Animal production and livestock production systems in the tropics</td>
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<td></td>
<td>- Special challenges for livestock in the tropics</td>
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<td>- Feeds available in the tropics</td>
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<td></td>
<td>- Tropical pasture systems and their characteristics</td>
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<td>- Quality of feeds in the tropics</td>
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<tr>
<td></td>
<td>- Problems and challenges in animal nutrition in the tropics</td>
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<thead>
<tr>
<th>Lecture notes / notice</th>
<th>Endocrinology and Biology of Reproduction</th>
<th>3 credits</th>
<th>2V</th>
<th>S. E. Ulbrich</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Die Studierenden erlangen das grundlegende theoretische Verständnis und Fachwissen zur Endokrinologie der Reproduktion und zur weiblichen und männlichen Reproduktionsbiologie. Sie können darüber hinaus pathologische Situationen (Fortpflanzungsstörungen) und deren vielfältigen Ursachen in den physiologischen Kontext einordnen.</td>
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<tr>
<td>Abstract</td>
<td>Die Systematik der Reproduktionshormone und der Hormonrezeptoren wird erläutert, die Wirkungsmechanismen (Bildung; orale Bioverfügbarkeit; Elimination) erklärt. Mit diesen Grundlagen wird das Verständnis der Regulation der Fortpflanzung umfassend erörtert.</td>
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### Ruminant Science

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-6001-00L</td>
<td>Forum: Livestock in the World Food System</td>
<td>W</td>
<td>2</td>
<td>1S</td>
<td>M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neuenschwander</td>
</tr>
</tbody>
</table>

Abstract: This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.
Objectives: In the Forum "Livestock in the World Food System", a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.

Content: The Forum "Livestock in the World Food System" will take place in blocks of 2 hours each. Once the general topic has been selected, it comprises two elements:

Element 1. Oral Presentation: The students form small groups and are lecturers. There are chair persons (moderators) from outside of these small groups and they also head the discussion. The remaining students and lecturers are the audience.

Element 2. Scientific writing: Option 1: preparation of a short scientific type of paper from a result table offered by the lecturers; Option 2: preparation of an abstract with limited word count from a scientific paper; Option 3: writing of a critical review of a paper. The students have to select 2 of the three options each. There will be a discussion be a discussion in small groups at two dates.

Introductions to both forms of presentation will be offered by lecturers.

The preparation of the oral and written presentations takes place to a small part during the 2-h blocks and mainly outside of this time.

Lecture notes: no scriptum

Prerequisites: Requirements for allocation of the two credit points:
- Theatre presentation (with handout) at the forum
- Delivery of written documents of sufficient quality
- Active participation during the presentations by the other participants

Literature: To be announced in the lectures.

751-6305-00L Livestock Breeding and Genomics W 3 credits 3G P. von Rohr

Abstract: Methods for analysing livestock data, in particular for the estimation of breeding values: principles of selection index, introduction to BLUP, application of common models used, relationship matrix, methods for the estimation of variance components, basics of breeding programs. The material will be illustrated via exercises and assignments.

Objective: The students are able to set up design matrices, the relationship matrix and its inverse as well as the Mixed Model equations to estimate BLUP breeding values for smaller examples.

Content:
- Selection index (various sources of information, one trait, multiple traits)
- Relationship matrix and its inverse
- BLUP: one trait, repeated observations, multiple traits, economic indices
- Introduction to methods for the estimation of variance components
- Assignments

Lecture notes: Copies of the slides are available on the net.

751-6501-00L Ruminant Science (HS) W+ 4 credits 4G M. Kreuzer, M. C. Härdi-Landerer, E. Hillmann, U. Witschi

Abstract: The course provides the scientific basis of the central aspects of reproduction, husbandry and nutrition physiology of ruminants, and of the implications for animal welfare, product quality, breeding programs, and organic livestock systems. Means of knowledge transfer include interdisciplinary approaches, disciplinary parts, web-based learning and self-study.

Objective: At the end of the course the students are able to apply, by a comprehensive understanding of the underlying mechanisms, their knowledge in various fields of ruminant science. They will be able to develop and recommend best strategies for breeding programs, feed formulation, improving forage quality, increasing animal health and welfare etc. They will be trained to carry out interdisciplinary and disciplinary research at the highest level. The course Ruminant Science (FS) offered in spring has a similar structure but is complementary to this course.

Content:
- Fields (contact hours)
- Introduction: 2 h
- Special topics: 12 h
  - Lameness
  - Fertility in Cows
  - Food Intake of Ruminants
- Disciplinary topics: 36 h
  - Ruminant Husbandry: 16 h
  - Ruminant Nutrition Physiology: 10 h
  - Reproduction in Ruminants: 8 h
- Lectures held by the students: 4 h

In summary:
- Contact hours: 52 h
- Self-study within semester: 30 h (especially preparation for the interdisciplinary courses and the own lecture)
- Self-study in semester break: 38 h
Total: 120 h

Lecture notes: Documentation, links and other materials will be provided at the start of the course

Prerequisites:
- Information on books and other references will be communicated during the course.
- The specialty of this course is that for the first time the animal science disciplines are unified. This is realised with a particular emphasis on interdisciplinary special topics and new forms of teaching. At the same time the essential basics in the central fields are communicated.

The field of Ruminant Science will also be a part of the spring semester (special topics: Organic Ruminant Systems, Tropical Ruminant Systems, Mastitis; disciplinary courses: Cattle, Sheep and Goat Breeding, Ruminant Diseases and Prophylaxis, Ruminant Nutrition and the Environment). However both courses are organized independently.

Conditions for successful participation: Background on animal science from the Bachelor is desired. In order to attend the Minor in Ruminant Science without any animal science background, a realistic self-assessment concerning the need for additional self-study is recommended (e.g. by choosing an appropriate bachelor course which then may be counted as 'optional courses' in the master). These efforts depend on the extent to which animal science courses have already been attended in the bachelor.

The control of performance will consist of:
- an own lecture
- a final oral examination with focus on comprehension of the fundamental linkages rather than of specific details

751-7211-00L Ruminal Digestion W 1 credit 1G A. Schwarm

Abstract: This course broadens the knowledge in one of the most important aspects of ruminant nutrition: the microbial digestion in the rumen (and in the hindgut). For a comprehensive understanding of the rumen microbial ecosystem, the mechanisms of nutrient fermentation and the synthesis of microbial protein, thorough basics are provided. Apart from lectures, group and laboratory exercises are included.
Objective

The course enables students to understand in detail how ruminal digestion works and how this knowledge can be applied to design optimal feeding diets using highly fibrous forages and a variety of other feeds. The students also are able to show how to modify the most important rumen microbes beneficially by nutritional means.

Content

Structure of the contact hour part of the course (14 h):

2 h Introduction and blackboard exercise

8 h Basic topics in ruminal digestion, lectures and group exercises:
- Systematics of the microbes involved in microbial digestion
- Measurement of microbial digestion
- Interactions of microbes and epithelium of the digestive tract
- Differences between ruminal and hindgut microbial digestion
- Microbial nutrient degradation and its modification
- Efficiency of microbial protein synthesis
- Manipulation of the ruminal digestion

2 h Laboratory exercise with a rumen fistulated cow and the Rumen Simulation Technique

2 h Final seminar

The non-contact hour part is to comprehend the information given and to prepare either the written report or the oral presentation (cf. "Besonderes")

Lecture notes

Lecture notes are provided via Moodle.

Literature

Will be communicated at the start of the course.

Prerequisites / notice

The course is a balanced mixture of blackboard exercise, laboratory exercise, group exercise, lecture and student seminar presentation. Credit point associated with grade of either a written report or an oral presentation in the final seminar (both on a self-chosen related topic)

751-7703-00L Tropical Animal Nutrition W 1 credit 1G S. Marquardt

Abstract

Farm animals play an important role in most agro/eco - systems, but conditions for a successful management and nutrition in the tropics are diverse. In this course a wide range of aspects are examined.

Objective

The aim of this course is to know and understand animal production systems in the different zones of the tropics taking into consideration the local and social structure of the population. We will deal with different aspects of animal nutrition in the tropics.

Content

- Introduction to the tropics
- Special problems and challenges in tropical regions
- Importance of livestock in the tropics
- Animal production and livestock production systems in the tropics
- Special challenges for livestock in the tropics
- Feeds available in the tropics
- Tropical pasture systems and their characteristics
- Quality of feeds in the tropics
- Problems and challenges of animal nutrition in the tropics

751-6113-00L Endocrinology and Biology of Reproduction W 3 credits 2V S. E. Ulbrich

Abstract

Die Systematik der Reproduktionshormone und der Hormonrezeptoren wird erläutert, die Wirkungsmechanismen (Bildung; orale Bioverfügbarkeit; Elimination) erklärt. Mit diesen Grundlagen wird das Verständnis der Regulation der Fortpflanzung umfassend erörtert.

Objective

Die Studierenden erlangen das grundlegende theoretische Verständnis und Fachwissen zur Endokrinologie der Reproduktion und zur weiblichen und männlichen Reproduktionsbiologie. Sie können darüber hinaus pathologische Situationen (Fortpflanzungsstörungen) und deren vielfältige Ursachen in den physiologischen Kontext einordnen.

Safety and Quality in Agri-Food Chain

Number Title Type ECTS Hours Lecturers
751-1555-00L Applied Food Industrial Organisation W+ 3 credits 2G to be announced

Abstract

Concepts of microeconomics and Industrial Organization and their application to the European food sector. Aspects include industry structure as well as strategic performance and performance of food sector firms.

Objective

Understanding and application of theoretical concepts along the Structure-Conduct-Performance paradigm. Ability to apply theory to empirical settings: understand and critically evaluate empirical industrial organization research and to replicate the results of such research using econometric methods

Content

- Introduction IO
  - Relevant topics for the food sector
  - high competition and market saturation
  - low R&D intensity
  - bargaining power of retailers
  - Private label introduction
- Theoretical Approaches
  - Structure Conduct Performance
  - Market Based View
  - Porter Five Forces
  - Resource Based View
  - Knowledge Based View
- Empirical Issues (Based on published research papers)
  - Competition / Concentration
  - Profitability
  - Impact of Innovation / R&D
  - Efficiency
  - Market power
  - Econometric Approaches

Literature

Several theoretical and empirical IO related research papers

752-2122-00L Food and Consumer Behaviour W 2 credits 2V M. Siegrist, C. Hartmann

Abstract

This course focuses on food consumer behavior, consumer’s decision-making processes and consumer's attitudes towards food products.
The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

752-2307-00L Nutritional Aspects of Food Composition and Processing
- 3 credits
- 2V
- B. E. Baumer, J. M. Sych

Objective
- Lecture course with an interdisciplinary approach for the evaluation of nutritional aspects of changes in food composition due to processing.
- Students should be able to:
  - describe and compare the major concepts/criteria used for the evaluation of the nutritional quality of food.
  - apply these criteria when assessing the effects of selected processing technologies on nutritional quality.
  - evaluate recent formulation strategies aimed to achieve additional physiological benefits for targeted population groups (i.e., functional foods).

Content
- The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g., nutritional profile) will be addressed.

Lecture notes
- There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course.

Prerequisites / notice
- The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing.

751-4203-00L Horticultural Science: Case Studies (HS)
- 2 credits
- 2G
- L. Bertschinger, J. Rösti, V. J. U. Zufferey

Number of participants limited to 24.

Abstract
- Lectures address 2 horticultural cropping systems and value chains, each one in 4 2h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated before. An excursion to a research site might be included. In a final colloquium, each group presents a report on their case study and their conclusions.

Objective
- Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind.
- Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.

Content
- In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture.
- The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and branch into ongoing research and development projects.

Lecture notes
- Documents handed out during the case studies.

Literature
- As provided by the case study leaders.

Prerequisites / notice
- The course builds on basic knowledge delivered in ‘Horticultural Crops I’ and ‘Horticultural Crops II’. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student.

Language: spoken E, G or F, Documents: Preferably English, G/F possible.

751-6001-00L Forum: Livestock in the World Food System
- 2 credits
- 1S
- M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neuenschwander

Abstract
- This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.

Objective
- In the Forum “Livestock in the World Food System”, a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.

Content
- The Forum “Livestock in the World Food System” will take place in blocks of 2 hours each. Once the general topic has been selected, it comprises two elements:
  - Element 1. Oral Presentation: The students form small groups and are lecturers. There are chair persons (moderators) from outside of these small groups and they also head the discussion. The remaining students and lecturers are the audience.
  - Element 2. Scientific writing: Option 1: preparation of a short scientific type of paper from a result table offered by the lecturers; Option 2: preparation of an abstract with limited word count from a scientific paper; Option 3: writing of a critical review of a paper. The students have to select 2 of the three options each. There will be a discussion be a discussion in small groups at two dates.

Lecture notes
- no script

Prerequisites / notice
- Requirements for allocation of the two credit points:
  - Theatre presentation (with handout) at the forum
  - Delivery of written documents of sufficient quality
  - Active participation during the presentations by the other participants.

752-5111-00L Gene Technology in Foods
- 3 credits
- 2V
- L. Meile

Abstract
- This course will increase basic knowledge on biotechnological constructions and application of genetically modified organisms (GMO) which are used worldwide in food production systems. The course discusses health issues, the legislation frame and food safety aspects of GMO applications in agriculture, food production and consumption in Switzerland and EU-countries.

Objective
- This course will provide knowledge and biological background on genetically modified organisms (GMO) and food produced with the help of GMO, especially on the molecular basis of GMO constructions with emphasis on genetically modified food in Switzerland and the EU. Criteria of rationale food safety and health assessment in agriculture and food consumption will be elaborated.

Content
- Overview on application in gene technology, the gene transfer potential of bacteria, plants and other organisms and the mostly used transgenes in food as well as on GMO used for food production and their detection technologies in food; food safety assessment of GMO food; information on the legislation in Switzerland and EU-countries.

Lecture notes
- Copies of slides from lectures will be provided.

Literature
- Actual publications from literature will be provided.

Prerequisites / notice
- Good knowledge in biology, especially in microbiology and molecular biology are prerequisites. Some contents will be provided by registered students who will individually or as a group present an actual publication.

751-0021-00L World Food System Summer School
- 4 credits
- 6P
- N. Buchmann

Number of participants limited to 25.

It is necessary to apply and be selected in order to participate in this course. This also applies to ETH Zurich.
Lecturers

The content framework includes the following modules: world food system overview; agricultural production; Global change drivers; smallholder livelihoods and rural development; Agroforest systems; labelling; International policy and trade; Processing, distribution, and retail; Nutrition and health; National policy and state interventions. The course will conclude with a group work on food system challenges.

Further information available:
http://www.worldfoodsystme.ethz.ch/education/summer-schools/upcoming.html

Abstract

Provide the opportunity for young scientists and practitioners to understand the challenges and opportunities of sustainable agriculture and organic production systems and to connect these to the broader context of the world food system. During the two week summer school at the Gut Rheinau, one of Switzerland’s largest organic farms, participants will engage in lectures, workshops, group work, case studies, and the respective impacts on individual and societal decision-making.

Objective

Understand: the science, relationships, interactions and trade-offs in food systems; the role and potential of organic production systems; potential interventions; the cultural, socio-political, economic and environmental factors to be incorporated into solutions. Build skills in systems thinking, multi-cultural and multi-disciplinary collaboration, participatory processes. Connect to a network of expert faculty/scientists/practitioners.

Content

The content framework includes the following modules: world food system overview; agricultural production; Global change drivers; smallholder livelihoods and rural development; Agroforest systems; labelling; International policy and trade; Processing, distribution, and retail; Nutrition and health; National policy and state interventions. The course will conclude with a group work on food system challenges.

Literature

Handouts are provided by the lecturers

Prerequisites / notice

No prerequisites. Program is open to Masters, PhD and upper level Bachelor students.

Transdisciplinary Methods and Applications

701-1543-00L

Transdisciplinary Methods and Applications

W

ECTS

Hours

Lecturers

Type

3

2G

P. Krütli, M. Stauffacher

Objective

At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2017

Content

The lecture is structured as follows:

- Overview of concepts and methods of inter-transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

Lecture notes

Handouts are provided by the lecturers

Literature

Selected scientific articles and book-chapters

Sustainability Assessment

701-1551-00L

Sustainability Assessment

W

ECTS

Hours

Lecturers

Type

3

2G

P. Krütli, C. E. Pohl

Objective

At the end of the course students should:

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content

The course is structured as follows:

- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Trade-offs in selected examples.

Lecture notes

Handouts

Literature

Selected scientific articles and book chapters

Master’s Thesis

751-1030-00L

Master’s Thesis

O

ECTS

Hours

Lecturers

Type

30

64D

Lecturers

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;

b. fulfilling of any additional requirements necessary to
gain admission to the master programme.

Abstract
The Master thesis is an independent scientific work. Normally the subject is selected among the topics of the core subject. It is written under the guidance of a agricultural science professor.

Objective
The independent writing of a scientific paper/thesis

Agroecosystem Sciences Master - Key for Type

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<th>Key</th>
<th>Type</th>
<th>Description</th>
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<td>O</td>
<td>Compulsory</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Suitable for doctorate</td>
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Key for Hours

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<th>Key</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td></td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Applied Geophysics Master - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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### Key for Hours

<table>
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<tr>
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<th>Type</th>
<th>Code</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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**ECTS**: European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
## Architecture Bachelor

### First Year Basic Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0111-00L</td>
<td>Architecture I</td>
<td>O</td>
<td>1 credit</td>
<td>2V</td>
<td>C. Kerez, H. Frei</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td>In a series of lectures aspects of the architectonical space will be exemplified and put into a theoretical context.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
<td>Training of a conscious perception and a conceptual understanding of the architectural space as well as techniques for its representation.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>051-0151-00L</td>
<td>Architectural Technology I</td>
<td>O</td>
<td>1 credit</td>
<td>2V</td>
<td>A. Spiro, D. Fiederling</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
<td>Knowledge of construction principles and its history. Cognition of correlation between concept, buildings structure, material and form.</td>
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</tr>
<tr>
<td></td>
<td><strong>Content</strong></td>
<td>In the triad of typology, topology and tectonics, the latter is the primary focus of the theoretical discourse. The series of lectures identifies the most disparate tectonic principles which transcend time and geography, and elucidates the reciprocally generative parameters of construction, technology and form. The lectures themes convey fundamental concrete constructional and practical knowledge and concentrate on the guidance of the basic exercises (Architectural Technology I + II).</td>
<td></td>
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</tr>
<tr>
<td>051-0211-01L</td>
<td>Architecture and Art I</td>
<td>O</td>
<td>1 credit</td>
<td>2V</td>
<td>K. Sander</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td>Theory and practice in the visual arts: Artistic thinking and practice.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
<td>Independent artistic thinking. Acquisition of artistic criteria.</td>
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</tr>
<tr>
<td></td>
<td><strong>Content</strong></td>
<td>Reflection of visual contents and phenomena. Examination of current positions in art.</td>
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</tbody>
</table>

### First Year Examinations

#### Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0411-00L</td>
<td>Structural Design I</td>
<td>O</td>
<td>4 credits</td>
<td>4G</td>
<td>P. Block, J. Schwartz</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td>The course is an introduction to structural design using graphical methods and structural models, with a focus on a creative approach rather than repetitive calculations. Cable and membrane structures, arch and shell structures and combined arch and cable systems will be used to demonstrate these methods.</td>
<td></td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
<td>Alle Konzepte, Herangehensweisen und Methoden werden in den wöchentlichen Vorlesungen eingeführt und in den anschliessenden Übungen vertieft.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
<td>All concepts, approaches and methods will be introduced in the weekly lectures and practiced in subsequent exercises.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>051-0853-00L</td>
<td>Building Materials I</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>J. Carmeliet, M. Koebel, O. von Trzebiatowski, F. Winnefeld, T. A. Zimmermann Schütz</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td>Building Materials - Structure, Quality, Usage concrete and other mineral materials metals, wood, glass and polymers ecological aspects</td>
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</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
<td>The lecture describes the fundamental properties of the most important construction materials: concrete and other mineral materials, metals, wood, glass and polymers. Furthermore, the content includes the relevant ecological aspects such as availability of raw materials, effort for production, emission of hazardous substances, disposal and recycling are treated as well.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Content</strong></td>
<td>The lecture describes the fundamental properties of the most important construction materials: concrete and other mineral materials, metals, wood, glass and polymers. Furthermore, the content includes the relevant ecological aspects such as availability of raw materials, effort for production, emission of hazardous substances, disposal and recycling are treated as well.</td>
<td></td>
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</tr>
<tr>
<td>051-0811-00L</td>
<td>Sociology I</td>
<td>O</td>
<td>1 credit</td>
<td>2V</td>
<td>C. Schmid</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td>Sociology I investigates the relation between social developments and the production of the built environment from a macro-sociological point of view. It examines central aspects of social change, historical and present-day forms of urbanization, and typical examples of models of urbanization.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
<td>This series of lectures should enable students to comprehend architecture in its social context. It approaches the architectural profession from two different angles: macro-sociological and micro-sociological.</td>
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Data: 06.11.2018 12:57 Autumn Semester 2016 Page 84 of 1571
Sociology I deals with the macro-sociological point of view, and investigates the relation between social developments and the production of the built environment. In the first part some central aspects of social change are examined in particular the transition from Fordism to Postfordism and from Modernism to Postmodernism, and the interlinked processes of globalization and regionalization. The second part deals with historical and present-day forms of urbanization. Among other aspects treated here are the changed significance of urban-rural contrasts, the processes of suburbanization and periurbanization, the formation of global cities and metropolitan regions, the growth of new urban configurations in centres (gentrification) and on urban peripheries (edge city, exopolis). In the third part these general processes are illustrated by typical models of urbanization.

### Examination Block 3

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**
The lecture conveys historical knowledge about architecture and art as well as methodical knowledge as a preparation for the independent handling of historical sources and scientific literature. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.

**Objective**
Acquisition of basic knowledge of the history of art and architecture, resp. of methodical basic knowledge of historical working.

**Content**
The history of art and architecture is part of our reality: it confronts us in the historically shaped environment of the city and plays an essential role in the creation of architecture. The historical lectures are therefore part of the fundamental courses of the undergraduate programme in architecture. On the basis of cultural and art-historical research the courses impart knowledge about architecture and art from ancient times to the present. At the same time they sharpen the perception for the conditions and capabilities of building activity in history. Moreover, they convey methodical knowledge and technical language skills and are meant as a preparation for the independent handling of historical sources and scientific literature.

The first one-year course aims at these goals in the form of exemplary epoch representations which through light upon the historical continuities. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.

**Lecture notes**
3 Skripte sind auf der Professur, HIL C 70.5-6, erhältlich:
- Architektur der Klassischen Antike, Fr. 15.-
- Renaissance und Barock, Fr. 15.-
- Aufklärung bis Moderne, Fr. 15.-

**Prerequisites / notice**
Zu beziehen am Dienstag und Donnerstag

---

**Number** 051-0823-00L

**Title** Economics I

**Abstract**
Introduction to economics and to the analysis of markets.

**Objective**
Understanding of the basic economic concepts and models and of their application to real-world situations, notably on property markets.

**Content**
The course in economics extends over two semesters. The focus during the Fall term is on an introduction to economic thought. These considerations provide the fundamental requirements for the economic analysis of land, housing and urban markets in the following Spring term.

The Fall semester focuses on the economic way of thinking. We shall discover why A. Marshall defined economics as "a study of mankind in the ordinary business of life". The course introduces the student to the "big questions" in economics, such as the concept of rationality and its limits, factors driving supply and demand, the working of markets, the importance of the price system and the reasons why markets may fail.

There are many interactions between economic and social phenomena on the one hand, and the built environment on the other. Our knowledge of the fundamental economic principles will allow us to understand the workings of the housing, land, credit and real estate markets - markets of fundamental importance for the future architect. We consider questions such as: which are the major problems of the land market? Which factors determine the price of land? What are the economic drivers that shape the form of our cities? Which are the primary difficulties in designing a reasonable housing policy. Finally, the courses discuss the main determinants of real estate investment, both its risk and its opportunities.

**Lecture notes**
Unterlagen sind verfügbar unter https://moodle-app2.let.ethz.ch/course/view.php?id=283

**Literature**

Deutsche, französische und italienische Übersetzungen:
Grundzüge der Volkswirtschaftslehre (2012), Schäffer-Poeschel
Principes de l'économie (2013), Economica
Principi di economia (2012), Zanichelli

**Prerequisites / notice**
Der Teil Mikroökonomie wurde überarbeitet und ist als separates Buch verfügbar (Englisch). In der Vorlesung behandeln wir nur diesen Teil.
Mankiw, Gregory N and Mark P. Taylor, Microeconomics (2011), Cengage Learning

The course "Economics II (real estate and urban economics)" follows in the Spring term.

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**Number** 401-0001-00L

**Title** Mathematics I

**Abstract**
Description and discussion of curves and surfaces focusing on their generation by movement: Parameterization, tangent vector, tangent plane, ruled surfaces, developable surfaces. (Methods of vector geometry and differential calculus are used.)

**Objective**
Vertiefen und Ergänzen der mathematischen Kenntnisse und Fertigkeiten

Behalten einiger für das Studium der Architektur fundamentaler Begriffe und Strukturen im Rahmen der Mathematik

Erkennen, dass mathematische Beschreibung und Abstraktion zu neuen Einsichten führen und verborgene Zusammenhänge erschließen können

**Content**
First Semester: Description and discussion of curves and surfaces focusing on their generation by movement: Parameterization, tangent vector, tangent plane, ruled surfaces, developable surfaces. (Methods of vector geometry and differential calculus are used.)

Second Semester: Description and discussion of polygons and polyhedra: Platonic solids, Euler's formula, scale properties, proportions, golden mean, Fibonacci series, isometries, symmetry groups

**Lecture notes**
script available (in german)

**Prerequisites / notice**
Für Fragen zur Vorlesung oder zu den Übungen findet Freitags über Mittag eine Präsenz-Stunde statt. Anmeldung unter: https://ethz.doodle.com/poll/6yen6ixsae65b22
## Subjects with Semester Grade

<table>
<thead>
<tr>
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<th>Lecturers</th>
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<tr>
<td>051-0211-02L</td>
<td>Architecture and Art I (2-Semester Course, Exercise)</td>
<td>O</td>
<td>0</td>
<td>6U</td>
<td>K. Sander</td>
</tr>
<tr>
<td>Abstract</td>
<td>Artistic thinking and working is developed in the dialog through the actual completion of individual projects. The focal point lies in the formulation of a personal objective and the individual, artistic approach to this view which is discussed in joint corrective dialogues.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Competence in independent artistic thought and practice. Development of the criteria of theory and practice in the visual arts.</td>
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</tr>
<tr>
<td>Content</td>
<td>Artistic thinking and working is developed in the dialog through the actual completion of individual projects. The focal point lies in the formulation of a personal objective and the individual, artistic approach to this view which is discussed in joint corrective dialogues.</td>
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</tr>
<tr>
<td>051-0129-00L</td>
<td>Architectural Design I (2-Sem.-Course, Exercise)</td>
<td>O</td>
<td>0</td>
<td>6U</td>
<td>C. Kerez, D. Budik, C. E. Scheidegger</td>
</tr>
<tr>
<td>Abstract</td>
<td>During the two semesters HS16/FS17 different aspects of the architectonic space and its possibilities for transposition into divers medias will be examined.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Training of conscious perception of the architectonic space and the development of concepts of its basic definition.</td>
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<tr>
<td>Content</td>
<td>During the two semesters HS16/FS17 different aspects of the architectonic space and its possibilities for transposition into divers medias will be examined.</td>
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</tr>
<tr>
<td>051-0131-00L</td>
<td>Architectural Technology I (2-Semester Course, Exercise)</td>
<td>O</td>
<td>0</td>
<td>6U</td>
<td>A. Spiro</td>
</tr>
<tr>
<td>Abstract</td>
<td>Finding, analysing, testing and refining basic construction principles. In the focus are the interaction of architecture, technology and structure and the creative dialogue with other works of art and architecture.</td>
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<tr>
<td>Objective</td>
<td>Empirical and analytical acquisition of basic construction principles. Cognition of correlation between structure and form, between architecture, technology and buildings structure.</td>
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</tr>
<tr>
<td>Content</td>
<td>In a series of creatively designed exercises, various terms related to the subject area of Material - Structure - Space are made sensually tangible and are dealt with conceptually. Their interdependence will become apparent in the process and the relationship between tecktonics and visual expression will be studied. In addition, the influence of materials and their properties, of construction principles and their specific application as well as of planning and production processes on the form as the end result will be elaborated theoretically in a series of lectures.</td>
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### Second and Third Year Basic Courses

#### Examination Blocks

#### Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>051-0113-00L</td>
<td>Architecture III</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>D. Eberle</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lectures discuss determining factors in architectural design based on the basic terms place, structure, shell, program and materiality.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>The lectures aim at conveying an integral understanding of architecture: its development, its determining factors, and the influence of its societal context.</td>
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</tr>
<tr>
<td>Content</td>
<td>The lectures discuss significant determining factors in architectural design based on five basic terms place, structure, shell, program and materiality. Several architectural examples are being examined within their specific societal context with an emphasis on the interrelation of architecture, science, culture and art.</td>
<td></td>
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<tr>
<td>051-0153-00L</td>
<td>Architectural Technology III</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>A. Deplazes</td>
</tr>
<tr>
<td>Abstract</td>
<td>Addresses construction as integrating component of design processes, including considerations based on contemporary case studies. Elaboration of construction principles on the basis of solid and filigree structure theories.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Addresses construction as integrating component of design processes, including considerations based on contemporary case studies. Elaboration of construction principles on the basis of solid and filigree structure theories.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Addresses construction as integrating component of design processes, including considerations based on contemporary case studies. Elaboration of construction principles on the basis of solid and filigree structure theories.</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>051-0159-00L</td>
<td>Urban Design I</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>H. Klumpner, A. Brillembourg</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture series will introduce tools for reading contemporary urban conditions, urban models and operational modes. Urban development will be deciphered, presented as operational tools, extracted from cities where they have been tested and became exemplary samples, most relevant for providing the understanding of how urban landscape has taken shape as well as inspiration for future practice.</td>
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<tr>
<td>Objective</td>
<td>How can a glossary of tools be used as a basis for reading cities and recognizing in them current trends and urban phenomena? The lectures series will produce a glossary of operational urban tools with collected urban knowledge that provides students with an ‘improved’ manual to navigate theories. Urban Stories is a lecture series that aims to amplify your repertoire of urban instruments and empowers you to read cities and to critically reflect on the urban environment. The course will approach a series of case studies, employing an analytical, research-based model for crosscutting scale, political, economical and social components. Through this lens, and with our toolbox, we aim to tell the fundamental story of our cities from today and provide information, analysis and knowledge to help students prepare for justifiable own contributions and interventions in the future. Also the aspect of knowledge transfer will be considered in order to sensibilize the students to understand how to operate in an international context.</td>
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<tr>
<td>Content</td>
<td>How did cities develop into the cities we live in now? Which urban plans, instruments, visions, political decisions, economic reasonings, cultural inputs and social organization have been used to operate in urban settlements in specific moments of change? Which cities are exemplary in illustrating how these instruments have been implemented and how they have shaped urban environments? Can these instruments be transcribed into urban operational tools that we recognize within existing tested cases in contemporary cities across the globe? Urban form cannot be reduced to the physical space. Cities are the result of social construction, under the influence of technologies, ecology, culture, the impact of experts and accidents. Urban unconsidered processes respond to political interests, economic pressure, cultural inclinations, along with the imagination of architects and planers and the informal powers at work in complex adaptive systems. Current urban phenomena are the result of an urban evolution. The facts stored in urban environments include contributions from its entire lifecycle. That is true for the physical environment, but also for non-physical aspects, the imaginary city that exists along with its potentials and problems and with the conflicts that have evolved over time. Knowledge and understanding along with a critical observation of the actions and policies are necessary to understand the diversity and instability present in the contemporary city and to understand how urban form evolved to its current state. This lecture series will introduce urban knowledge and the way it has introduced urban models and operational modes within different concrete realities, therefore shaping cities. Urban knowledge will be translated into operational tools, extracted from cities where they have been tested and become exemplary samples, most relevant for providing the understanding of how urban landscape has taken shape. Case studies will be identified to compile documents and an archive, that we use as templates to read the city and to critically reflect upon it. The presented contents are meant to serve as inspiration for positioning in future professional life as well as to provide instruments for valuable contributions and interventions.</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>The skipt can be downloaded from the student-server.</td>
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</tbody>
</table>
There are "Lecture Notes" (in German) for this course. After a review of essential facts from the first year the course will examine the interplay of architectural concept and structural system by J. Schwartz.

The lecture series focuses on the physical principles and technical components of relevant systems for an efficient and sustainable energy supply and climate systems. This course aims at providing the necessary theoretical background in order to develop a basic understanding of mass transport and buffering of building materials. The course syllabus can be bought at the Chair of Building Physics. Prior knowledge of "BP I: heat" is required.

The Slides from the lecture serve as lecture notes and are available as download. Further information is available at http://www.hertig.ethz.ch/education/gz-des-rechts-fuer-architektur.html

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0413-00L</td>
<td>Structural Design III</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>J. Schwartz, P. Block</td>
</tr>
</tbody>
</table>

Abstract
After a review of essential facts from the first year the course will examine the interplay of architectural concept and structural system by analyzing buildings of exemplary quality. The focus will be on the integration of specifics of structural systems made out reinforced concrete or steel into architectural design.

Objective
Students are enabled to integrate essential characteristics of structural systems made out reinforced concrete or steel into their architectural design.

Content
After a review of essential facts from the first year the course will examine the interplay of architectural concept and structural system by analyzing buildings of exemplary quality. The focus will be on the integration of specifics of structural systems made out reinforced concrete or steel into architectural design.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>8051-0519-00L</td>
<td>Building Physics II: Moisture</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>J. Carmeliet, T. Defraeye</td>
</tr>
</tbody>
</table>

Abstract
70% of all construction problems are related to moisture. This course aims at providing the necessary theoretical background in order to foresee and avoid these problems.

Objective
to develop a basic understanding of mass transport and buffering to become aware of potential moisture-related damage and health risks to learn how to (i) design building components and (ii) assess their hygrothermal performance

Content
hygrothermal loads conservation of mass dry air: constitutive behaviour, transport, potential problems and solutions moist air: constitutive behaviour, transport, potential problems and solutions liquid water: constitutive behaviour, transport, potential problems and solutions moisture-induced degradation processes case studies exercises

Lecture notes
Handouts, supporting material and exercises are provided online (http://www.carmeliet.arch.ethz.ch/education/ with Building Physics II: Moisture in the Documents section). The course syllabus can be bought at the Chair of Building Physics.

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>8051-0551-00L</td>
<td>Energy- and Climate Systems I</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>A. Schlüter</td>
</tr>
</tbody>
</table>

Abstract
The lecture series focuses on the physical principles and technical components of relevant systems for an efficient and sustainable climatisation and energy supply of buildings. A special focus is on the interrelation of supply systems and architectural design and construction. Learning and practicing methods of quantifying demand and supply allows identifying parameters relevant for design.

Objective
1. Introduction
2. Heating and cooling
3. Active and passive ventilation
4. Electricity in buildings

Content
Lecture notes
The Slides from the lecture serve as lecture notes and are available as download. A list of relevant literature is available at the chair.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0703-01L</td>
<td>Introduction to Law for Architecture</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>G. Hertig</td>
</tr>
</tbody>
</table>

Students who have attended or will attend the lecture "Introduction to Law for Civil Engineering " (851-0703-03L) cannot register for this course unit.

Abstract
This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.

Objective
1. Public Law
2. Private law

Content
Constitutional law: sources of law, organization of the state, fundamental rights. Administrative law: administrative decisions, organization of the administration, enforcement of administrative decisions, procedural law, basics of police, environmental and zoning law.

Lecture notes
There are "Lecture Notes" (in German) for this course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0709-00L</td>
<td>Introduction to Civil Law</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>H. Peter</td>
</tr>
</tbody>
</table>

Further information is available at http://www.hertig.ethz.ch/education/gz-des-rechts-fuer-architektur.html

Examination Block 2
Students are free to take the exam either in German or in French. They may choose between 851-0710-00L Introduction to Law for Civil Engineering and Architecture or 851-0709-00L Introduction to Civil Law (French).
The course Private Law focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In addition, the course will provide a short overview of Civil Procedure and Enforcement.


Le cours de droit civil porte notamment sur le droit des obligations (droit des contrats et responsabilité civile) et sur les droits réels (propriété, gages et servitudes). De plus, il est donné un bref aperçu du droit de la procédure et de l'exécution forcée.

Editions officielles récentes des lois fédérales, en langue française (Code civil et Code des obligations) ou italienne (Codice civile e Codice delle obbligazioni), disponibles auprès de la plupart des librairies.

Sont indispensables:
- le Code civil et le Code des obligations;
- Sont conseillés:
- Nef, Urs Ch.: Le droit des obligations à l'usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
- Bolliod, J.-P.: Manuel de droit, éd Statkine, Genève

The lectures are accompanied by a script (two semesters of the bachelor studies), that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 30,-. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note.

Remarques

- Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalents des cours "Recht I" et "Recht II" en langue allemande et des exercices y relatifs.
- Les examens peuvent se faire en français ou en italien.
- Examen au 1er propédeutique; convient pour travail de semestre.

### Examination Block 3

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0311-00L</td>
<td>History of Art and Architecture III</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>L. Stalder</td>
</tr>
<tr>
<td>051-0363-00L</td>
<td>History of Urban Design I</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>V. Magnago Lampugnani</td>
</tr>
</tbody>
</table>

The two-semester course offers an introduction to the history and theory of architecture from the industrial revolution up to now. Based on current questions a variety of case studies will be discussed.

The subject of this lecture course is the history and theory of architecture since the beginning of the 19th century up to now. It examines the architectural answers to the changing technical inventions and social practices. Consequently, the focus will be less on individual architects or buildings than on various themes that determined the architecture of the period.

The lectures are accompanied by a script (two semesters of the bachelor studies), that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 30,-. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note.

Further recommended literature to consult is listet within the script. History of Urban Design from antiquity to the 19th century

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>051-0351-00L</td>
<td>Building Archeology and Conservation I</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>S. Holzer</td>
</tr>
</tbody>
</table>

Building archeology is an approach that provides in-depth insight into the historical documentary evidence provided by the traces of production, use, ageing, and repair which are preserved in a historical building. Based on an attentive reading of these traces, adequate methods of conservation and rehabilitation can be devised.

The students have a basic knowledge of the historical evolution of constructions. They are familiar with the techniques of documentation, analysis and interpretation of relevant features of historic buildings. They have basic knowledge of the history and theory of monument conservation. They are able to assess different measures of conservation and intervention.
### Examination Block 4

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0125-00L</td>
<td>Architecture V</td>
<td>O</td>
<td>1</td>
<td>3V</td>
<td>P. Ursprung</td>
</tr>
<tr>
<td>Abstract</td>
<td>History of Art and Architecture since the 1970s</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Objective</td>
<td>The course target is to let the students gain an overview of a line of formative occurrences, works of art, buildings and theories from the early nineteen-seventies. The students should become sensitive for questions and problems in the field of history and theory and they should increasingly be able to relate their own praxis with historical references.</td>
<td></td>
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<tr>
<td>Content</td>
<td>The two-semester course offers an introduction to the history of modern and contemporary art and architecture since ca. 1970. Motivated by questions of the current discourse, central topics and exemplary works of art and architecture are discussed. Concepts such as &quot;labor&quot;, &quot;economy&quot;, &quot;experience&quot;, &quot;research&quot;, &quot;nature&quot;, &quot;diversity&quot; or &quot;surface&quot; are used to focus on specific historical developments and connections. Art and architecture is considered as a field of cultural change as well as an indicator of social, economic, and political conflicts which in turn helps to understand historical dynamics. The course &quot;Lehrkanapé&quot; (one hour) is part of the course and treats alternative methods of teaching and learning.</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td><a href="http://www.ursprung.arch.ethz.ch/courses">http://www.ursprung.arch.ethz.ch/courses</a></td>
<td></td>
<td></td>
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</tbody>
</table>

| 051-0155-00L | Architectural Technology V                  | O    | 2    | 2V    | M. Peter           |
| Abstract     | The lecture series explores the correlation among intentions of design, architectonic expression and construction premises. These critical areas or aspects of study, which are presented with selected projects, their respective theoretical backgrounds and historical development, are pluralistically associated and brought into relation with varying contemporary opinion. |      |      |       |                    |
| Objective    | The final part of the lecture series Konstruktion V/VI aims to analyse (structural) construction techniques and their formal appearance and expression in their interrelation. The different themed parts of structural design, building shell and knowledge of material get connected with architectural design in practice and reflected in the wider context of architectural theory. The intention is to consolidate the understanding of the connection between structure, process and formal appearance and expression in the architecture of the 20th century. |      |      |       |                    |
| Content      | The lecture series in the course entitled Architecture and Construction explores the correlation among intentions of design, architectonic expression and construction premises. Each lecture is focused on individual themes, as for example, the application of certain materials (glass, or natural stone), of particular construction systems (tectonic, hybrid) or design generators (grids, series) and alternatively the search for a definable, tangible architectural expression (vernacular architecture, ready-mades). These critical areas or aspects of study, which are presented with their respective theoretical backgrounds and historical development, are pluralistically associated and brought into relation with varying contemporary opinion. The yearlong lecture cycle is comprised of twenty individual lectures, in which the majority of projects being analyzed date from the last few decades. |      |      |       |                    |
| Lecture notes| no script                                   |      |      |       |                    |
| Literature   | list of literature per lecture              |      |      |       |                    |

| 051-0615-00L | Design and Strategies in Urban Space I      | O    | 1    | 2V    | K. Christiaanse, M. Wagner |
| Abstract     | Means and potentials of urban design are depicted from different perspectives to illustrate how the city can be designed as a sustainable and humane environment. For this purpose general basic principles and specific methods of urban design are going to be presented. The lectures will be given by members of the chair and invited speakers. |      |      |       |                    |
| Objective    | This lecture series imparts advanced expertise in urban planning. The main focus is to illustrate the complex manner in which various methods are embedded in the everyday practice of planning and design by addressing pressing questions of contemporary urban design practice and theory. The goal is to communicate a broad-based systemic knowledge base, which helps enable students to synthesize and evaluate complex urban design and planning problems. |      |      |       |                    |
| Content      | The fall semester introduces the notion of strategic design and imparts further knowledge about the structure and models of the contemporary city. It is structured in two parts: |      |      |       |                    |
| Lecture notes| There is no script accompanying the lecture series. At the end of the semester the lecture slides and at the end of the 3rd year course a reader with secondary literature will be available for download on the homepage of the chair of architecture and urban design: http://www.christiaanse.arch.ethz.ch |      |      |       |                    |
| Literature   | At the end of the 3rd year course a reader with secondary literature will be available for download on the homepage of the chair of architecture and urban design: http://www.christiaanse.arch.ethz.ch |      |      |       |                    |
## Theory of Architecture I

Lecturers

The course covers the basic history and theory of garden design and landscape architecture from its beginnings to the 21th century. The

O C. Girot

Handouts and a reading list will be provided.

Alongside a discussion of the basic principles, trends and terminologies, a closer look will be taken at each topic using case studies that

### Literature

All the required readings will be uploaded online. In addition, it is recommended to consult the following sources:


### Objective

Understanding of the historic development and critical discussion of various intellectual contexts of architectural theory.

### Content

Architectural theory emerged as a product of the Renaissance worldview, which was both holistic and critical. Having developed alongside science, it shared the former's principles and premises. It aimed to explain the objective laws of beauty and to develop rules for their creation by architectural means. In the early twentieth century, modernism supplanted Classical architectural theory and attempted to replace it with the methods and axioms of the most cutting-edge branches of science, including engineering and psychology. Modernism's own principles were, however, soon condemned and rejected by its discontents. From the early 1970s onward, a variety of approaches have dominated architecture, none of them able to become its primary theory. Today, architectural theories no longer prescribe the rules of design. Instead, they offer solutions to the different problems that society poses for architecture, relying on methods and approaches of fields of inquiry that directly relate to these problems. In the course of the semester, we will seek to delineate this elusive space of contemporary architectural theory within the various intellectual contexts in which it operates in order to understand its role in architectural practice. The readings will introduce architectural theories written at different historic periods, while the lectures will situate them both theoretically and historically.

## Building Process I

### Content

The building process is the main focus of this lecture series. The process is understood as a sequence of criteria in time. These criteria are divided into acquisition and building legislation, building economics and facility management, the people involved and their work, construction and planning organization.

### Objective

Process thinking and a glance at our foreign neighbours complete the series.

### Literature

Sacha Menz (Hrsg.), Drei Bücher über den Bauprozess, vdf Hochschulverlag an der ETH Zürich, 2009

Literature

Literaturempfehlungen unter www.bauprozess.arch.ethz.ch.

## Landscape Architecture I

### Content

The lecture series on History and Theory of Garden Design and Landscape Architecture deals with the historical development of designed nature, from the beginnings of cultural landscapes and gardens to 21st century landscape architecture. In the analysis of each era, the focus is on the spatial and cultural relationship between the garden, the city and the landscape, as well as the changing perceptions of nature and its representation.

### Literature

Handouts and a reading list will be provided.

A reading list will be provided for the exams.

General Information for the final exam:

Bachelor students: The content of the lectures as well as texts and exam-relevant literature provided by the Chair make up the basis for preparing for the exam. The lecture series is conceived as a yearlong course. Since the written session examination will test knowledge from both semesters, it is necessary to fully attend the lectures of both courses "Landscape Architecture I" and "Landscape Architecture II". The themes of the examination will be announced at the end of the semester. The Chair will provide literature and texts available for download as pdfs. These allow a more in-depth understanding of the lecture material.

Exchange students or students from other departments: Students, who are attending only one semester, may pass the oral end-of-semester examination. Test-relevant literature will also be made available for download for this purpose. The students are requested to get in touch by email with the Chair.

## Architectural Design and Integrated Disciplines

### Architectural Design

#### Architectural Design (3. Semester)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0115-00L</td>
<td>Theory of Architecture I</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>A. Vronskaaya</td>
</tr>
<tr>
<td>051-0757-00L</td>
<td>Building Process I</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>S. Menz</td>
</tr>
<tr>
<td>051-0161-00L</td>
<td>Landscape Architecture I</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>C. Girot</td>
</tr>
</tbody>
</table>

#### Prerequisites / notice

Handouts and a reading list will be provided.

For the final exam:

Bachelor students: The content of the lectures as well as texts and exam-relevant literature provided by the Chair make up the basis for preparing for the exam. The lecture series is conceived as a yearlong course. Since the written session examination will test knowledge from both semesters, it is necessary to fully attend the lectures of both courses "Landscape Architecture I" and "Landscape Architecture II". The themes of the examination will be announced at the end of the semester. The Chair will provide literature and texts available for download as pdfs. These allow a more in-depth understanding of the lecture material.

Exchange students or students from other departments: Students, who are attending only one semester, may pass the oral end-of-semester examination. Test-relevant literature will also be made available for download for this purpose. The students are requested to get in touch by email with the Chair.
Architectural Design III: From the City to the House
(D. Eberle)  
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php). Students who do not wish to change the design class must not enrol.

Abstract  
The design course is built on various exercises. During Fall Term, the students are concerned with the conversion and densification of existing building structures at three different sites in Zurich.

Objective  
Conveying a way of thinking that is also able to understand complex contexts and act on various levels is one of the focuses of the chair. This networked thinking relates to praxis and educates the students to be competent architects.

Content  
Achieving this goal requires a method that teaches a clearly structured, precisely formulated approach and communicates the simultaneity of complex tasks and processes.

Literature  
Dietmar Eberle, Pia Simmendinger, From city to house - a design theory, gta Verlag 2007

Architectural Design III: Constructed Nature
(T. Emerson)  
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php). Students who do not wish to change the design class must not enrol.

Abstract  
Exercises will involve design and construction, from the definition of a concept to the execution of the detailed work. Work will include procedural methods for spatial designs through form, function, technology, and materials. To promote interdisciplinarity through integrated teaching.

Objective  
Achieving the goal of competent architects requires a method that teaches a clearly structured, precisely formulated approach and communicates the simultaneity of complex tasks and processes.

Content  
Exercises will involve design and construction, from the definition of a concept to the execution of the detailed work. Work will include procedural methods for spatial designs through form, function, technology, and materials. To promote interdisciplinarity through integrated teaching.

Architectural Design III: Housing (A. Deplazes)  
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php). Students who do not wish to change the design class must not enrol.

Abstract  
Systematic and methodical design and construction development. Full range from concept to detail. Fall semester highlights fundamentals on “collective housing”, under the specific aspect of building depth. Discusses relations with current interdisciplinary sets of problems.

Objective  
The target of the design work is to reinforce the sensibility for such a broad attitude and at the same time to develop the skills for its application. To deal with the reality of construction and material is thereby an important concern.

Content  
At the beginning of our investigation, based on different depths of buildings (6 to 21m), we formulate first basic rules of supporting-, room- and local public infrastructure for apartments. Based hereon and still without context we design a idealtypic apartment building with apartments of different size. Only after catching the rules of the building systematically, the urbanistic context and the front of the building will be introduced into the design process. This approach to the design task allows a self-supporting research of structural and living specific questions, this without being distracted rashly from outer inherent necessities.

Architectural Design (from 5. Semester on)

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Prerequisites / notice  
Arbeitsort: Atelier Gisel, Streuliistrasse 74a, 8032 Zürich
Anzahl Studierende: 16
Unterrichtssprache: Deutsch
Arbeitsweise: Einzelarbeit
Aufgabentyp: Entwurf
Ausführliches Semesterprogramm: www.caminada.arch.ethz.ch
### 051-1107-16L Architectural Design V-IX: Open (Gastdozentur)

| Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php). |
| W | 13 credits | 16U | to be announced |

**Abstract**
- To follow

**Objective**
- To follow

**Content**
- A semester reader with all important text sources and additional material will be provided. Design work in different fields of architecture and urbanism with integration of the knowledge acquired in the first years of studies,
- Capability to develop a design from an idea, a concept to an advanced project, to question the intermediate stages in a self-critical way,
- Developing various analytical and notation techniques for understanding culturally/ideologically molded architectural landscape: theoretical discussion of the social and architectural types of socialism with visionary potential; critical evaluation of compiled instruments; designing relevant architecture through examination of East Germany.


| Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php). |
| W | 13 credits | 16U | M. Angéli |

**Abstract**
- In the studio we will move between a landscape of ideas and the actual built landscape in East Germany, between visions and shrinking cities, between different social systems and layers of time with the goal of recovering interesting concepts from failed plans.
- Develop various analytical and notation techniques for understanding culturally/ideologically molded architectural landscape: theoretical discussion of the social and architectural types of socialism with visionary potential; critical evaluation of compiled instruments; designing relevant architecture through examination of East Germany.

**Content**
- "Draw from the heavens to the board," this quote - the title of an essay collection by East German architect Herman Henselmann - speaks of the euphoria, the optimism of progress, and the belief in the messianic potential of architecture and city planning characteristic of the early years of the GDR (1). Particularly when it was a young socialist state, the hope reigned that a better and more equal society could be developed through urban planning and architecture. The many socialist utopias are products of this revolutionary thinking. As the state actually developed, however, an ever-greater disillusionment grew instead. The initial hope dimmed in the face of authoritarian government and economic mismanagement. Since reunification, consensus has been that the GDR's system and its social visions have failed - a condemnation that is now being questioned.
- The first step will be an archaeological investigation of the utopian fragments within the ruins of former visions, assembling an inventory of projects and socialist types with visionary potential. In a critical reflection from a contemporary perspective, the content of the architectural imprint of socialism is to be explored in order to find tools for dealing with today's territories of emigration and economic collapse.
- In this way, could it be possible to develop a future for East Germany and elsewhere that doesn't put a false 'heaven' of growth and repopulation back on the drawing board, but rather, considerately and critically continues the past trajectory in a new light? Could we develop both visionary and pragmatic architectural interventions that enliven the landscape without actually imagining that it flourishes? (2)


**Lecture notes**
- Integrated Discipline Planning (P) included LV No. 063-1401-14

**Prerequisites / notice**
- - Course numbers for inscription:
  - LV No. 051-1113-14 U (Design)
  - LV No. 063-1401-14 (Integrated Discipline Planning)
- - Work format: individual and group work
- - Assistants for the design course:
  - Michael Hirschbichler, 044 633 38 21, hirschbichler@arch.ethz.ch
  - Marcin Ganczarski
  - Ciro Miguel
- - Course introduction/Special event: 16.09.2013, 10:30h, ONA studio;


| Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php). |
| W | 13 credits | 16U | A. Gigon |

**Abstract**
- Designing Architecture, which sounds the potential of its usage, its location, the city, the society and its culture and transforms these into a coherent spatiality and materiality by a distinct concept.

**Objective**
- Capability to develop a design from an idea, to an advanced project, to question the intermediate stages in a self-critical way, thereby finding an individual design method and attitude.

**Content**
- Design work in different fields of architecture and urbanism with integration of the knowledge acquired in the first years of studies, supported by experts in related sciences (e.g. structural engineering, landscape architecture, history of art and architecture, historic preservation etc.)

### 051-1119-16L Architectural Design V-IX: Living Lab Zakynthos - Testing Sustainability 1:1 (D.Hebel)

| W | 13 credits | 16U | D. Hebel |

- This studio will be conducted one single time in Fall 2016 as a collaboration between the Chilean architect Smiljan Radic and Christian Kerez.

- Burda (from Wikipedia, the free encyclopedia, 2016) Burda Style (formerly: Burda Moden) is a fashion magazine published in 17 different languages and distributed in over 99 countries. It was founded in 1950 by Aenne Burda and is published today by Hubert Burda Media. The magazine appears monthly and contains patterns to sew women's and children's clothes, at time also mens clothes.

- burda (from Williams diccionario español-inglés inglés-español, 1991) burdo -da: adj coarse, clumsy, rough; f (naut.) backstay

- Both contradictory notions of 'burda' will guide us through a semester that regards itself as a search for the textile, raw, ephemeral, adaptable, and sensual space. The students participating in the atelier will design three autonomous projects in various scales.
This semester we will be designing a future-oriented, sustainable accommodation complex on the rural west coast of Greece. The ambition of the project Living Lab Hotel is to test how our future lives could be led in a world without consumption and destruction of natural resources. It is expected that the outcome of the studio will be realized by the client.

You will develop the project based on your own definition of sustainability. The availability of resources, craftsmanship and talents as well as the climatic, ecological and economic conditions shall be integrated into the design of an innovative architectural project. The issue of contemporary tourism and its accompanying economic model will influence and inform your spatial concept. We will work together with local partners to develop a strategy to implement the project. The scheme should consist of several pavilions, a lobby, administration building, educational facilities, as well as an infrastructural system for deliveries, supplies and sustainable disposal. You will be expected to work across a variety of scales, resolving individual buildings details as well as masterplanning.

To begin the semester we will travel to Zakynthos from September 15 to 19 to investigate the site and understand its relationship the local context. We invite you to participate in this trip and ask you to reserve the dates. Additionally, we offer a seminar week to Venice to visit the 15th architecture biennale, "Reporting from the Front", where explorations into future-oriented architecture as envisaged by young and innovative protagonists are exhibited within one of the most sophisticated cityscapes of Europe. Participation in both the site visit and the seminar week is strongly recommended but not mandatory.

The chair offers the integrated discipline Construction within the course. Additionally, the integrated disciplines Architecture and Building Systems and Structural Design are offered under chairs Arno Schlüter and Philippe Block respectively. The course Life Cycle Assessment is also offered in collaboration with Roland Hischier (EMPA). You may select a maximum of two integrated disciplines. A seminar week is offered on this subject to interested students. Participation is strongly recommended but not mandatory. The designs created include material-specific, architectural as well as constructive investigations, drawings and models.

Whether London, Boston or Copenhagen, the centers of cities move towards the water. Amsterdam too is looking for a new relationship with its fast developing areas on the north-side of the estuary IJ, which separates Amsterdam's north from its south. Whether London, Boston or Copenhagen, the centers of cities move towards the water. Amsterdam too is looking for a new relationship with its fast developing areas on the north-side of the estuary IJ, which separates Amsterdam's north from its south. Amsterdam Waterfront

In our design studio we pursue the question of the future meaning of Amsterdam's north based on the case study site of Draad en Kabelfabriek (Oraza). Urban design concepts should investigate the area in the context of a larger spatial vision for Amsterdam's waterfront. Supported by the Chair of Cognitive Science (professorship Christoph Hölscher) we will search for innovative approaches and transformation strategies for the waterfront's possible development. Hereby both superordinate connections as well as specific on-site conditions will be part of our consideration.

The design studio includes a four day trip to Amsterdam at the beginning of the semester (participation recommended). The processing of the design task takes place in teams of 3-4 students. Detailed information on design studios will be announced in advance to the registration process on the homepage of the chair of architectural design and urban planning. To evaluate complex urban design and planning problems and to synthesize their knowledge in an urban design project.

As a studio we are interested in educating future architects who understand that architecture is by definition a political practice, and that the architect must become a vigorous policy-whisperer, if anything.

Architectural Design V-IX: Amsterdam Waterfront

Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

| Prerequisites / notice | 051-1121-16L | Architectural Design V-IX: Amsterdam Waterfront (K. W 13 credits 16U) K. Christiaanse Christiaanse) |

Abstract
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

Objective
The goal is to communicate a broad-based systemic knowledge base, methodologies and strategies, which helps to enable students to evaluate complex urban design and planning problems and to synthesize their knowledge in an urban design project.

Content
Amsterdam Waterfront

Whether London, Boston or Copenhagen, the centers of cities move towards the water. Amsterdam too is looking for a new relationship with its fast developing areas on the north-side of the estuary IJ, which separates Amsterdam's north from its south.

Concurring with the closing of two big shipyards in the 1980s a transformation process started along the waterfront. Nowadays new developments cover almost the entire shoreline of the IJ. Its central location right next to the central station, its proximity to the water and the vast areas abandoned by the former industries, make the waterfront an attractive development area and field of experimentation for new actors and for the implementation of new uses. The planning vision of the 'sprong over het IJ' - the jump over the IJ is within reach but the question what kind of city should emerge there is still open.

In our design studio we pursue the question of the future meaning of Amsterdam's north based on the case study site of Draad en Kabelfabriek (Oraza). Urban design concepts should investigate the area in the context of a larger spatial vision for Amsterdam's waterfront.

Supported by the Chair of Cognitive Science (professorship Christoph Hölscher) we will search for innovative approaches and transformation strategies for the waterfront's possible development. Hereby both superordinate connections as well as specific on-site conditions will be part of our consideration.

Prerequisites / notice

| Prerequisites / notice | 051-1123-16L | Architectural Design V-IX: A Policy Whispering Practice (GD P. Swinnen) W 13 credits 16U P. Swinnen |

Abstract
Our 2016 fall semester will focus on the social and spatial possibilities of massive energy production in dense and socially challenged areas; investigating how architectural strategies of energetic abundance can produce unseen yet fruitful concepts for metropolitan cohabitation. The first testing site will be Brussels.

Objective
As a studio we are interested in educating future architects who understand that architecture is by definition a political practice, and that the architect must become a vigorous policy-whisperer, if anything.
The politics and economics of renewable energy are society's contemporary topicality par excellence; a market-driven urgency around which some of which some of the most unbanked politicized lobbying is performed.

However, the technological savvy of wind, solar, hydro, tidal, geothermal, and biomass energy hold - without exception - no fundamental spatial intelligence. These technologies are commonly applied onto the most efficient territories or structures available. The spatial output is residual and secondary. The juxtaposition of all these individual decisions clutters exponentially the limited space at hand. Moreover policy guidelines related to the spatial application of renewable energy are chiefly defensive, passive and reluctant in their ambition. Behind this political lassitude lies - amongst others - a fundamental shortage of spatial and architectural imagination on how these new technologies can strengthen and steer near-future metropolitan landscapes.

051-1125-16L Architectural Design V-IX: Arrival "Stadtwald" Cable Car Stettbach-Zurich
W 13 credits 16U M. Sik
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract
Architectural design based on place, category, modification and built form.

Objective
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

Content
A new cable car will connect the public transport hub Stettbach directly with the new terminal station of the number 5 and 6 trams to the zoo. This calls for the design of a new type of terminal building with additional commercial spaces that can serve as attractive center for every day and recreational activities.

The outdoor and landscape design includes arrival, parking and common spaces.

Prerequisites / notice
- Integrated Discipline Landscape Architecture (G. Vogt) 051-1235-16L
- Integrated Discipline Construction (D. Mettler/D. Studer) 051-1201-16L
- Critics every 2 weeks
- Professur Miroslav Sik, HIL G75.2, Tel 044 633 28 13, Fax 044 633 10 81, sik@arch.ethz.ch
- Introduction 20.09.16, 10.00 Uhr, HIL G61

051-1129-16L Architectural Design: Apartment Building, Scale and City Shape (M. Peter/C. Dumont d'Avoy)
W 13 credits 16U M. Peter, C. Dumont d'Avoy
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

Objective
Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design methodology and attitude.

051-1131-16L Architectural Design V-IX: Hermitage (GD Van Hee)
W 13 credits 16U M. J. Van Hee
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract
Each student individually designs a space as an alternative environment apart from the ordinary and the daily routine. The intervention reflects on the dramaturgy of the topography, on the verge between the sacred buildings of the hermitage like the Chapel of St. Verena or the St. Martin's Chapel and the secular buildings in the existing context of a beautiful gorge.

Objective
The aim of this term is to enable and assist students to take charge of their own design process. Our thematic focus lies on sacral and secular structures and on the integration of a project in the landscape. A small sized building or construction should be technically developed.

Content
For as long as there has been civilization, there have been people who want to get away from it. A hermitage usually refers to a place where a person lives for religious or ideological reasons in seclusion from society. In contrast to that way of life the idea of the 'ornamental hermits' or the 'garden hermits' enjoyed growing popularity in the English landscape gardens of the 18th century where they served mainly as entertainment to the high society.

In this semester we want to consider the role of the hermitage in a post-metaphysical world in order to reflect about nowadays retreats. We will work in the St. Verena Schlucht, a gorge that connects the city of Solothurn to the village of Rüttenen at the southern foot of the Jura chain. The actual hermitage is an enclosed space at the end of an 800m long scenic pathway that leads through a gorge filled with pastoral romance typical for the late 18th century French romantic landscape gardening. Until this day the St. Verena Schlucht, with its steep forest slopes and its slow-flowing ditch, offers to tourists, to excursionists as well as to inhabitants of Solothurn a place for recreation in a landscape where borders between nature and architecture are vanishing.

051-1133-16L Architectural Design V-IX: Topic (N.N. Professor)
W 13 credits 16U to be announced
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract
To follow
Objective
To follow
Content
To follow
Prerequisites / notice
The semester will start with the development of an urban vision in groups of six, which will then evolve into a proposition for a master-plan. The latter will be the base for individual projects, developed in groups of two. Working with references will be an important aspect of the studio: the typological collection of buildings gathered by the chair will provide the raw material for the own projects. Model photography will be the primary design tool, which will be professionally assisted be the photographers Roman Keller. A workshop will take place in Brussels during the second studio week, from the 22nd to the 24th of September. The trip and accommodation costs will be taken in charge by the chair.

Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract
The Alps as Common Ground
With each design semester the Chair of Professor Vogt is working its way around the Alpine arc with the thesis that it can be read as an urban Common Ground. The task of each design semester is to verify this thesis by focusing on a metropolitan region and enquiring as to its specific relationship with the Alps.
The first aim of the studio is to allow a shift of focus on architecture, to see the buildings from the outside and their relation both to the urban Common Ground and the surrounding neighborhoods to the waterfront, while generating an overall urban vision that tackles issues related to tourism, infrastructure, preservation, environment, mobility, and resource.

The task of the semester consists of the redifinition of the meaning and use of the alpine landscape ranging between extensification (landscape as a museum) and intensification (e.g. tourism, agriculture or energy production) with the purpose to establish a productive relation to the region of Ljubljana.

We understand design not as an end product but as a process. Our first step is to investigate Ljubljana's large-scale relationships. A six-day long field trip complements this analytical gaze with a personal take on the area. Students then develop an individual programme as the foundation for their design. The proposed interventions can vary between urban planning and landscape scenarios and concrete architectural proposals.

The contribution towards expenses will be 240 CHF.

| Objective | Independent thinking and acting. |
| Content | The Alps as Common Ground |
| With each design semester the Chair of Professor Vogt is working its way around the Alpine arc with the thesis that it can be read as an urban Common Ground. The task of each design semester is to verify this thesis by focusing on a metropolitan region and enquiring as to its specific relationship with the Alps. |
| In the coming semester we shall be working with the urban territory of Ljubljana, which covers besides the high alpine landscapes (the Julian Alps, the Karavanks, the Kamnik Alps) three more alpine regions: the Dinarides (Karst), the Pannonian Basin and the Mediterranean Coast. Geographically almos the whole territory of Slovenia could be seen a part of Alps. |
| Though this supposed ubiquity of the Alps, the correlation to Ljubljana remains diffuse. This is linked to the geopolitical location of the region, which was constantly changing its territorial belonging to the neighboring great powers throughout history. Moreover, the emerging industrialization in the beginning of the century and the development of the transit axis were leading to population decrease in the high alpine area. This weakened their position compared to the lower districts considerably. Looking at major infrastructure projects that are planned like the Connecting Europe Facility (CEF), it may be assumed that this trend will continue. As a consequence, economic and living areas in Slovenia's high Alps will soon «disappear» (Werner Bätzing). |
| The task of the semester consists of the redifinition of the meaning and use of the alpine landscape ranging between extensification (landscape as a museum) and intensification (e.g. tourism, agriculture or energy production) with the purpose to establish a productive relation to the region of Ljubljana. |

| Lecture notes | The Workbook is released in the first week. |
| Literature | The relevant literature is included in the workbook. |
| Prerequisites / notice | Process Cartography |
| Assistants: Thomas Kissling, Ilkay Tanrisever, Sebastiano Brandolini |
| Design (051-1135-15 U - 13 KP) and integrated discipline planning / landscape architecture (051-1235-15 U - 3KP) |
| There will be a visit to Ljubljana 07.10.16 - 12.10.16. |
| The contribution towards expenses will be 240 CHF. |

051-1137-16L | Architectural Design V-IX: High-Rise and Public Space W (GD X. De Geyter) |
| Please register (www.my.studies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php). |
| Abstract | The first aim of the studio is to allow a shift of focus on architecture, to see the buildings from the outside and their relation both to the exterior and to the public interest. This displacement opens new fields of possibilities for architecture. |
| Objective | The first aim of the studio is to allow a shift of focus on architecture, to see the buildings from the outside and their relation both to the exterior and to the public interest. This displacement opens new fields of possibilities for architecture. It is also about providing the students with the necessary understanding to consider public space as an architectural project itself in order to liberate the same creative process that they already have considered for building design. |
| Content | The studio will focus on the design of a university campus building and its immediate surrounding, the architecture will result from the dialogue and relationship to the campus and the urban environment. The aim of the project will be to investigate concepts of campus buildings including their public space. The designs will not necessarily concern an entire building, depending on the situation; students will possibly elaborate a critical part of the campus building such as a lobby, a roof, a basement, a plaza or an interior circulation. One of three campus situations can be chosen: one 'splendid isolation', one submerged in the city fabric and one dominating a small town. After a short-exercise (1 week) and a masterplan conducted in groups (4 weeks), the project will be developed individually (10 weeks). The production will include models, collages and drawings, amongst others medias. |
| Prerequisites / notice | After a short-exercise (1 week) and a masterplan conducted in groups (4 weeks), the project will be developed individually (10 weeks). The production will include models, collages and drawings, amongst others medias. |

051-1139-16L | Architectural Design V-IX: Port of Havana (A.Brillembourg/H.Klumpner) |
| Please register (www.my.studies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php). |
| Abstract | Working directly with the Havana city government and local institutions, students will design alternative architectural typologies and inclusive urban visions that challenge conventional approaches of urban development characterized by privatization, fragmentation and gentrification. |
| Objective | With an end to the U.S. embargo in sight, fifty-six years after the Cuban Revolution, Havana is confronted with probably the most challenging opportunity for urban development in the Americas. At the heart of this development -- and the site of our studio -- is Havana's recently decommissioned harbor, consisting of 1000 hectares of state-owned land currently lacking any comprehensive plan. Working directly with the Havana city government and local institutions, students will design alternative architectural typologies and inclusive urban visions that challenge conventional approaches of urban development characterized by privatization, fragmentation and gentrification. Students will propose architectural projects that react to the existing built legacy, absorb the influx of capital investment, and connect the surrounding neighborhoods to the waterfront, while generating an overall urban vision that tackles issues related to tourism, infrastructure, preservation, environment, mobility, and resource. |

| W | 13 credits |
| A. Brillembourg, H. Klumpner |

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Today, with the relocation of all industrial activities to the newly opened port of Mariel on the outskirts of the city, and the possibility of the U.S. blockade being lifted at any moment, a wealth of investment is being directed at the port of Havana presenting a new challenge for this vast stretch of latent land in the center of the city. Because the political system means that the state owns all of the land, the direction of the development is up to them. Struggling between globalization, modernization, and the country's revolutionary socialist tradition, an alternative solution to the global commercially driven development is needed.

Can the city accept and direct this global investment while preserving its local cultural ideals? Will it learn from its specific experiences and develop its own creative urban solutions for a sustainable growth? Or will it replicate the usual mistakes of rapid urban development seen in many cities of today? Can we define this new urban agenda, together?

A series of lectures, screenings, readings and discussions will accompany the design program. Workshops and in-studio tutorials will also be provided to train students in effective methods of representing complex ideas through visual media. These will be given by selected experts from the fields of architecture, urbanism, landscape, building technologies and associated disciplines, as well as experts from the Urban-Think Tank Chair.

The Reader will be handed out at the first meeting and is in English only.

Reading material will be provided throughout the semester, as well as references to similar case studies.

The class material can be downloaded from the student-server.

For more information on this studio, please refer to our Chair's website: www.u-tt.com/teaching/fall2016studio

The development of this studio will benefit from the findings of our "Learning from Havana" summer school, which will be held from 22 August to 2 September, developed in close partnership with Prof. Christian Schmid (Chair of Sociology at D-ARCH ETH) and Prof. Jorge Peña Díaz (Faculty of Architecture of CUJAE, La Habana) who have been mapping and studying Havana over the past ten years.

The seminar week to Havana, Cuba is not obligatory but highly recommended.

Integrated Discipline: Planning
Language: English / German
Work: Groups (2 per)
Location: QNA, E25

Chair: Prof. Brillembourg & Prof. Klumpner

Assistants: Danny Wills, Hans-Christian Rufer

All inquiries can be directed to: Danny Wills - wills@arch.ethz.ch

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The semester offers an intensive fieldwork and studio program, with an opportunity for students to focus on large-scale territorial research and design projects. Architecture of Territory’s approach enables students to work with a wide range of methods and sources pertaining to territory, including ethnographic research, literature, architectural and urban design precedents, urban theory, photography and visual art.

Students will work in groups of two. All projects will compose a common vision for Lac Léman. The work will be represented in the form of drawings, physical models and a book. All projects will be made public on Architecture of Territory website.

Lac Léman and its urban areas surrounding the lake and extending from the lakesides into the Rhone valley and up the slopes of Jura and the Alps, will serve as the blueprint for the investigation of the Metropolitan Countryside. This is a territory where the high quality metropolitan living is embedded into the scenic landscapes of agricultural land and nature: the lake, the vineyards and the mountain slopes are not just a scenic urban backstage, but the key ingredients of the metropolis. The two poles of the “Léman City”, Geneva and Lausanne, define one of the most desirable international metropolises in the world, which owns its attractiveness to international institutions and businesses, and its high quality of life, precisely to the unique, countryside-like attributes of its urban landscape. Intrigued by this apparently productive contradiction, Architecture of Territory initiates a two-semester investigation on the area of Lac Léman. For autumn semester 2016, we will study the concept of Metropolitan Countryside, investigating the possibilities of bringing the countryside and the metropolis closer together.

What are the benefits and potentials of agricultural land and nature for the contemporary metropolis? What are the new concepts of urban living, not only in the city, but in the extended metropolitan setting?

Investigative journey constitutes the core of the project. The field research will be organised in form of several group and individual excursions. The mandatory group trip will take place from 8-12 October 2016. Students who have obligatory courses on Monday, October 10, are required to organize their substitution or dispensation, in order to enrol. Additional 2-3 day individual trip to the research site will be required, and planned with the teaching team depending on the project task. Cost frame B.

Architecture of Territory is looking for avid travellers and team workers with high motivation and independent position.

**Prerequisites**
- Please enroll also for: Integrated seminar week (19.-23.10.15) in Zurich; Cost range: A.

**Literature**
- Relevant course literature will be handed out in form of a reader and to be downloaded from the student server.

**Notice**
- Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

**Lecture notes**
- Start: Tue 20 Sept, 10 am, DNA
- Places: 18 students (teams of 2 students)
- Travel: Integrated trip 8-12 October (cost frame B)
- Integrated Discipline: Planung 063-1402-16

**Contact**
- markaki@arch.ethz.ch
- www.topalovic.arch.ethz.ch
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of architecture and architecture, monuments conservation etc.).

**Objective**
Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design methodology and attitude.

**Content**
To follow

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-1105-16L</td>
<td>Architecture Design V-IX: Built Territories / Añana</td>
<td>W</td>
<td>13</td>
<td>16U</td>
<td>J. M. Sánchez García</td>
</tr>
</tbody>
</table>

**Abstract**
"Built Territories Añana" explores the complementary relationship between territory and urban context, prompting students to create efficient structures for visitors and residents of Añana, but more importantly to engage in an ongoing discussion on how the construction of architecture informs cultural, social and physical landscapes.

**Objective**
1. Identify and analyze research resources that are adequate for the development of the project.
2. Acknowledge theoretical issues in order to develop a critical posture related to the design process.
3. Acknowledge the needs of inhabitants and translate them into a creative and sensible proposal.
4. Demonstrate advanced knowledge in representing architecture according to/challenging existing conventions.
5. Defend creative proposals in reference to various contextual issues informing architectural design.

**Content**
The idea that humans are the main geological agent on Earth has been around for some time now, especially since in 2000 the atmospheric chemist Paul Crutzen coined the term Anthropocene to refer to the influence of human behavior on Earth's lithosphere in recent centuries.

The Salt Flats of Añana, in Northern Spain, were naturally formed in the Triassic Period as a result of a process known as diapir, a type of geologic intrusion in which a more mobile and deformable material is forced into overlying rocks, allowing the salty water of the sea to emerge in this inland valley of the Basque Country.

Romans are believed to have operated this landscape industrially, though the first documented use dates back to 822, when Añana was started to be used with economic purposes. The landscape commenced then to be transformed in order to maximize the surface area exposed to the sun, turning the valley into a territory of platforms, subtly supported underneath by an architecture of timber-frame structures. At the time of maximum splendor, there were in the valley more than five thousand platforms for evaporation, occupying an area of 95.233m². Adjacent to the exploitation, the village of Añana was progressively built as a satellite rather than as a center, turning the salt flats into the very civic space of the valley.

"Built Territories Añana" explores the complementary relationship between territory and urban context, prompting students to create efficient structures for visitors and residents of Añana, but more importantly to engage in an ongoing discussion on how the construction of architecture informs cultural, social and physical landscapes. Due to the economic development of the region over the last decades, the population of Añana has diminished. However, the role of this territory as the definer of the collective memory of the site and its society remains untouched. Far from a nostalgic vision, the salt flats behave as an elastic territory that can shrink or expand at demand.

Thematic and methodic focus:
- Design architectural landscapes taking into account a wide range of urban, socio-cultural, economic and historical issues that are inherently connected with architectural practices.
- Recognize environmental and landscape issues that are relevant to contemporary architectural agendas.
- Consider and negotiate structural, material, functional, interior and exterior space aspects as well as all urban issues that concern the project simultaneously.
- Represent idea(s) appropriately using effective means of presentation, including digital tools.

**Research Work:**
The Seminar Week features visits to Añana + 6 built territories in Spain. In the first three weeks of the semester each student will research and compare Añana + 1 built territory, focusing on the way the encounters between city and territory, nature and artifice, topography and construction are addressed in different scales and contexts. This will help students understand the transformation of these territories, their construction and geometry as technical and economical rather than stylistic phenomena, irrespective of the particular time frame of each site.

**Literature**
http://www.doz.arch.ethz.ch/gastdoz/sanchezgarcia/hs2016-entwurf.html


**Abstract**
The course will focus on the constructive and structural challenges of the realization. Main topic is the quality of the architectural space in the area between physical necessity and the freedom of design. The competences of all elective courses and main courses have been merged into a single, extensive course.

**Objective**
As a didactic target a profound debate on supporting structure, on construction and on room creation is declared.

**Content**
In consequence of the historic fact that the builder's profession has been divided into the professions of an engineer and an architect, a bisection of fields came up which reflects in the various types of building tasks. Hence, nowadays engineers realize a number of structures without considering an architect's expertise. However, the functional expertise of the engineers should be merged with the design ideas of architects. That opens a field between freedom of design and functional/technical requirements.

As such buildings characterize our environment exceedingly and represent a substantial part of it, a high sophisticated design is very important for our society.

Therefore structural aspects are evaluated to their spatial and tectonic qualities. For this reason the course does not deal with classic architectural design tasks. The focus is on engineering structures.

**Integrated Discipline Construction**
The integrated Discipline Construction can also be completed as "additional integrated Discipline", but the integrated Discipline Construction must be chosen at least once.

**Number**  | **Title**                                      | **Type** | **ECTS** | **Hours** | **Lecturers**         |
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>051-1201-16L</td>
<td>Integrated Discipline Construction (D.Mettler/D.Studer)</td>
<td>W</td>
<td>3</td>
<td>2U</td>
<td>D. Mettler, D. Studer</td>
</tr>
</tbody>
</table>

**Abstract**
In the context of the semester-long design projects, the reciprocity between design, construction and materiality is reinforced.

**Objective**
The integration of knowledge gained in the basic courses lends the work an additional dimension and demands of the students an increasingly integrative ability to think and design.

**Content**
This part of the curriculum addresses design work in different areas of architecture and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of architecture and architecture, monuments conservation etc.).
### Additional Integrated Disciplines

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-1203-16L</td>
<td>Integrated Discipline Building Research and Preservation of Cultural Heritage</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>to be announced</td>
</tr>
<tr>
<td>Abstract</td>
<td>The formal framework needs to be discussed with the staff members.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>A study in building research and preservation of building heritage with a clear topic.</td>
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</tr>
<tr>
<td>051-1205-16L</td>
<td>Integrated Discipline History of Urban Design (N.N.)</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>V. Magnago Lampugnani</td>
</tr>
<tr>
<td>Abstract</td>
<td>The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The written essay should be at least 10 pages. The formal framework needs to be discussed with the assistants.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>An urban history case study with a clear topic and a clear formulation of a question. The findings and the discoveries shall be part of the base of the design.</td>
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</tr>
<tr>
<td>Content</td>
<td>The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The written essay should be at least 10 pages. The formal framework needs to be discussed with the assistants.</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>There is no reader.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Suggestions will be given at the discussions.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Voraussetzung ist die Anmeldung unter mystudies.ethz.ch und per e-mail an die Professur bis zum Ende der ersten Semesterwoche unter Angabe des Entwurthemas und der betreuenden Professur, sowie die Teilnahme am Kolloquium in der zweiten Semesterwoche zur allgemeinen Einführung und konkreten Besprechung der Integrationsleistung (Ort und Uhrzeit der Kolloquien werden auf der Homepage des Lehrstuhls Lampugnani bekannt gegeben). Die Abgabefrist erfolgt analog zum Entwurf.</td>
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<tr>
<td>051-1207-16L</td>
<td>Integrated Discipline History of Art and Architecture (P.Ursprung)</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>P. Ursprung</td>
</tr>
<tr>
<td>Abstract</td>
<td>The work should be part of the design process and interact with it formally and in regard to content.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Works in the integrated discipline art and architectural history evolve in close connection with projects in design. Textual and creative works are possible. The length of the text or the extent of the creative project will be decided upon individually.</td>
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<tr>
<td>Content</td>
<td>We expect that students pursue their examination of the design process independently and in an original manner or that they develop a related theme from the perspective of the history of art and architecture.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Students interested in this course are required to enroll via mystudies.ethz.ch and apply via e-mail at the chair until end of the first week of the semester. Students are asked to indicate the theme of the design and the chair they are working with. The work is handed in at the same time as the design.</td>
<td></td>
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<tr>
<td>051-1209-16L</td>
<td>Integrated Discipline History of Art and Architecture</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>L. Heinze-Greenberg</td>
</tr>
<tr>
<td>Abstract</td>
<td>A short written essay and/or design work will be integrates in the design project.</td>
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<tr>
<td>Objective</td>
<td>The aim is a profound examination of a topic of history of art and architecture. The gained insights will be converted into the design process.</td>
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<tr>
<td>Content</td>
<td>Die integrierte Studienleistung ist dem Entwurf beigeordnet, doch muss eine klar erkennbare eigenständige Leistung in Form einer kurzen schriftlichen und/oder gestalterischen Arbeit erbracht werden. Die Themenwahl erfolgt in enger Absprache mit dem Lehrstuhl. Form und Umfang der Arbeit werden im Vorhinein abgesprochen.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Voraussetzung ist die Anmeldung unter mystudies.ethz.ch und per Email an die Professur bis zum Ende der ersten Semesterwoche unter Angabe des Entwurthemas und der betreuenden Professur. Die Arbeit muss zwei Wochen vor der Schlusskritik des Entwurfes abgegeben werden.</td>
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<tr>
<td>051-1211-16L</td>
<td>Integrated Discipline Theory of Architecture (NF Moravanszky)</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>to be announced</td>
</tr>
<tr>
<td>Abstract</td>
<td>No course in HS16</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>No course in HS16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>No course in HS16</td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>In the bachelor program, the integration of architectural theory into the design process is only offered in cooperation with the chair of architectural design for the whole design studio. On the basis of a reading of theoretical texts the conventions of architectural practice are critically debated. The theoretical perspective will be discussed in the midterm and/or final design studio criticism.</td>
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<tr>
<td>Objective</td>
<td>The goal is a critical debate on the conventions of architectural practice, the insights of which shall inform the design process.</td>
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</tr>
<tr>
<td>Content</td>
<td>In the bachelor program, the integration of architectural theory into the design process is only offered in cooperation with the chair of architectural design for the whole design studio. On the basis of a reading of theoretical texts the conventions of architectural practice are critically debated. The theoretical perspective will be discussed in the midterm and/or final design studio criticism.</td>
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</tbody>
</table>
### Integrated Discipline Building Physics (J. Carmeliet)

**Prerequisites / notice:** Limited number of participants.

**Abstract:** Enrolment under mysteries and per email to the chair is compulsory by the end of the 1st semester week at the latest! Please specify your design theme as well as the name of the supervising chair.

**Objective:**
The goal is that the students learn to evaluate hygrothermal performance of the building in the different stages of the design process. The students learn to evaluate and optimize their design, to choose adequate wall solutions and materials, to design details from a perspective of hygrothermal performance.

**Content:**
Hygrothermal analysis of a building wall component
Detailing regarding hygrothermal behaviour

**Literature:**
http://www.caad.arch.ethz.ch

---

### Integrated Discipline CAAD (L. Hovestadt)

**Prerequisites / notice:** Interested students may enroll at mystudies.ethz.ch and by an email to the chair until the end of the second week of the semester. The topic and the design chair should be mentioned in this email.

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### Integrated Discipline Building Systems (A. Schlüter)

**Prerequisites / notice:**

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### Integrated Discipline Architecture and Digital Fabrication (F. Gramazio/M. Kohler)

**Prerequisites / notice:**
Grant by lecturer is required.

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### Integrated Discipline Building Physics (J. Carmeliet) V 3 credits 2U J. Carmeliet

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### Integrated Discipline CAAD (L. Hovestadt) V 3 credits 2U L. Hovestadt

---

### Integrated Discipline Building Systems (A. Schlüter) V 3 credits 2U A. Schlüter

---

### Integrated Discipline Architecture and Building Process (S. Menz) V 3 credits 2U S. Menz

---

### Integrated Discipline Structural Design (J. Schwartz) V 3 credits 2U J. Schwartz

---

### Integrated Discipline Architecture and Digital Fabrication (F. Gramazio/M. Kohler) V 3 credits 2U F. Gramazio, M. Kohler

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**Data:** 06.11.2018 12:57

**Autumn Semester 2016**

**Page:** 100 of 1571
Content
We use the term digital materiality to describe an emergent transformation in the expression of architecture. Materiality is increasingly being enriched with digital characteristics, which substantially affect architectures physis. Digital materiality evolves through the interplay between digital and material processes in design and construction. The synthesis of two seemingly distinct worlds—the digital and the material—generates new, self-evident realities. Data and material, programming and construction are interwoven. This synthesis is enabled by the techniques of digital fabrication, which allows the architect to control the manufacturing process through design data. Material is thus enriched by information; material becomes informed. In the future, architects ideas will permeate the fabrication process in its entirety. This new situation transforms the possibilities and thus the professional scope of the architect.

051-1227-16L Integrated Discipline Information Architecture W 3 credits 2U G. Schmitt
- Abstract
  This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).
  Objective
  Apart from learning about and experiencing Information Architecture, the course also introduces research and management skills that will distinguish the future trained ETH architect.
- Content
  This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

051-1231-16L Integrated Discipline Sociology
- Abstract
  This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates sociological questions and research methods.
  Objective
  To consider the social context in the design process!
- Content
  The content is related to the design process and is defined accordingly to the individual project.

051-1233-16L Integrated Discipline Architecture and Urban Design
- Abstract
  The integrated local work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.
  Objective
  An urban design case study with a clear topic and a clear formulation of a question. The findings and the discoveries shall be part of the base of the design.
- Content
  The integrated local design work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.

051-1235-16L Integrated Discipline Landscape Architecture
- Abstract
  The integrated local work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.
  Objective
  Learning objectives: introduction into landscape architectural issues and design approaches; designing in urban planning dimensions.
- Content
  Subject by arrangement

051-1237-16L Integrated Discipline Landscape Architecture
- Abstract
  Design concepts ranging from architectural objects to urban planning are developed together with the discipline of landscape architecture.
  Objective
  Students gain an insight into the integrated disciplines of design in architecture together with landscape architecture.
- Content
  Design concepts ranging from architectural objects to urban planning are developed together with the discipline of landscape architecture.
  Prerequisites / notice
  In order to complete the subject Integrated Discipline it is necessary that students apply at the Chair of C. Girot within the first three weeks of the semester. Thereafter no applications will be processed.

051-1245-16L Integrated Discipline Structural Construction
- Abstract
  Implementation into architectural design of the gained structural construction knowledge, in order to find best possible and holistic solutions for a construction task.
  Objective
  The integrated course achievement is allocated to the design course and is fulfilled under the supervision of professionals out of the field of structural teaching. The main focus, the form and the scope of the thesis are specified in agreement with the chair.
  Content
  The integrated course achievement is shown within the design course of Prof. Christiaanse, the assistants.
  Prerequisites / notice
  Die Anzahl Plätze ist beschränkt!

051-1247-16L Integrated Discipline Architecture and Art
- Abstract
  In the integrated discipline the architectural design will be juxtaposed by artistic thinking and working. The conceptional approach will in particular be rendered more precise in the dialogue between architectural and artistic methods. There is also a focus on the technique of describing the context precisely.
  Objective
  Art is the discipline that is constantly creating new realities of terminology and perception. The purpose of the integrated discipline is to use this knowledge, that is produced by art, and to concern it by making design decisions.
  Content
  A systematic procedure for every step in the design will be supported in the integrated discipline, from the generation of new ideas through to detailing and presentation. Reflections on method flow into the design in an integrated manner. There will also be an emphasis on giving expression to the results of the design process using artistic means. In addition a publication should be compiled, presenting the conceptual steps developing the design.
  Prerequisites / notice
  Application for the coursework with the lecuturer: Nikolai von Rosen, vonrosen@arch.ethz.ch

051-1251-16L Integrated Discipline Life Cycle Analysis
- Abstract
  Learning objectives: introduction into landscape architectural issues and design approaches; designing in urban planning dimensions.
  Objective
  Learning objectives: introduction into landscape architectural issues and design approaches; designing in urban planning dimensions.
  Content
  Subject by arrangement

051-1255-16L Integrated Discipline Structural Construction
- Abstract
  Implementation into architectural design of the gained structural construction knowledge, in order to find best possible and holistic solutions for a construction task.
  Objective
  The integrated course achievement is allocated to the design course and is fulfilled under the supervision of professionals out of the field of structural teaching. The main focus, the form and the scope of the thesis are specified in agreement with the chair.
  Content
  The integrated course achievement is shown within the design course of Prof. Christiaanse, the assistants.
  Prerequisites / notice
  Die Anzahl Plätze ist beschränkt!

051-1256-16L Integrated Discipline Life Cycle Analysis
- Abstract
  Learning objectives: introduction into landscape architectural issues and design approaches; designing in urban planning dimensions.
  Objective
  Learning objectives: introduction into landscape architectural issues and design approaches; designing in urban planning dimensions.
  Content
  Subject by arrangement
The Integrated Discipline LCA is based on the core idea of the overall design task - the thinking of a project within its complete life cycle. The method of LCA allows to quantify the environmental sustainability of different life stages of a building (raw materials - construction - operation - decommissioning) and thus recognize their relevance to each other as well as present them clearly.

Objective

Introduction to the topic of sustainability and teaching of fundamental method of life cycle assessment as well as its application in architecture and construction. Practical use of these method in a simplified form to assess your own planning activities within the parameters of the design studio.

Content

The Integrated Discipline LCA is divided into two phases - the first phase will convey the methods of LCA through a mix of lectures, examples and an exercise, in order to be applied in the second phase in a simplified, yet meaningful manner in close connection with the central task of the design studio. In the center of the 2nd exercise is the specific design and constructive approach of the individual student group. Building on there design, the results of exercise 2 should be prepared so that they are suitable for integration into the final presentation wall. For this exercise should be seen as part of the overall task and relevant input for the whole semester.

Seminar Weeks

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0911-16L</td>
<td>Seminar Week Autumn Semester 2016</td>
<td>W</td>
<td>2 credits</td>
<td>3A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract

The seminar week is obligatory for students of all semesters. There are many and varied study contents.

Objective

The students will be enabled to discuss narrowly formulated factual questions in small groups and in direct contact with the professors.

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-ARCH.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Architecture Bachelor - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The lecture covers the time of the 20th century and describes with theories, projects and implemented planning the history of the modern Design and Building Process MBS.

A. Paulus

To each lecture an overview is listed within a script, that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 5,-. The script is in German, the Quellentextbände (source texts) which help to extend the knowledge of theoretical discourses in the field of urban design. For the master program the institute offers one volume of texts at the price of CHF 25,-. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note. Aside this script the chair offers the Quellentextbände' (source texts) which help to extend the knowledge of theoretical discourses in the field of urban design. For the master program the institute offers one volume of texts at the price of CHF 25,-. The script is in German, the Quellentextbände are reprinted in their original languages.

1. Le Corbusier: theories, visions and clearcuts in the name of the autorité
2. The United States in the Jazz Age: Between Metropolis of Tomorrow and Broadacre City
3. Italy in the Fascist Era: Monumental ensembles and new town between assiduousness of modernization and obsession of representation
4. Urban design under totalitarian regimes: The architects of the "Tausendjährige Reich" and the "engineers of luck" of the Soviet Union of Stalin
5. Coming to terms with the past and the Cold War: Reconstruction in the two German states
6. The myth of the human scale: the 1950s in Spain, Great Britain, Scandinavia and Italy
7. Postwar Experiments: Rationalistic classicism in France
8. Two new towns in the 20th century: Chandigarh and Brasilia
9. Fictions and visions: The international utopia of the city
10. The second conquest of the North American territory: The automobile and the city in the USA
11. Analysis, analogy and renewal: The adventure of the typological city

Lecturers

Further recommended literature to consult is listed within the script.

"Design and Building Process MBS" is a brief manual for prospective architects and engineers covering the competencies and the responsibilities of all involved parties through the design and building process. Lectures on twelve compact aspects gaining importance in an increasingly specialised, complex and international surrounding.
Objective

Participants will come to understand how they can best navigate the design and building process, especially in relation to understanding their profession, gaining a thorough knowledge of rules and regulations, as well as understanding how involved parties’ minds work. They will also have the opportunity to investigate ways in which they can relate to, understand, and best respond to their clients’ wants and needs. Finally, course participants will come to appreciate the various tools and instruments, which are available to them when implementing their projects. The course will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship.

Content

“Design and Building Process MBS” is a brief manual for prospective architects and engineers covering the competencies and the responsibilities of involved parties through the design and building process. Twelve compact aspects regarding the establish building culture are gaining importance in an increasingly specialised, complex and international surrounding. Lectures on the topics of profession, service model, organisation, process, design quality, coordination, costing, tendering, construction management, contracts and agreements, life cycle, real estate market, and getting started will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship. The course introduces the key figures, depicts the criteria of the project and highlights the provided services of the consultants. In addition to discussing the basics, the terminologies and the tendencies, the lecture units will refer to the studios as well as the practice: Teaching-based case studies will compliment and deepen the understanding of the twelve selected aspects. The course is presented as a moderated seminar to allow students the opportunity for individual input: active collaboration between the students and their tutor therefore required.

063-0363-00L Urban History Online. Methods for Text and Plan

<table>
<thead>
<tr>
<th>Analysis</th>
<th>No course in HS16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>No course in HS16</td>
</tr>
<tr>
<td>Content</td>
<td>No course in HS16</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>No additional reader is on offer for this course.</td>
</tr>
</tbody>
</table>

Prerequisites / notice

The three blocks of the course are related to the lecture «The history of the architecture of the city». The course can be attended in two modes, either in combination with the above-mentioned lecture or independently as a single course. The entire course is held in german.

051-0515-16L Building Physics IV: Urban Physics

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Urban physics: wind, wind comfort, pollutant dispersion, natural ventilation, driving rain, heat islands, climate change and weather conditions, urban acoustics and energy use in the urban context.</th>
</tr>
</thead>
</table>
| Objective| - Basic knowledge of the global climate and the local microclimate around buildings  
- Impact of urban environment on wind, ventilation, rain, pollutants, acoustics and energy, and their relation to comfort, durability, air quality and energy demand  
- Application of urban physics concepts in urban design |
| Content  | - Climate Change. The Global Picture: global energy balance, global climate models, the IPCC process. Towards regional climate scenarios: role of spatial resolution, overview of approaches, hydrostatic RCMs, cloud-resolving RCMs  
- Urban micro climate and comfort: urban heat island effect, wind flow and radiation in the built environment, convective heat transport modelling, heat balance and ventilation of urban spaces - impact of morphology, outdoor wind comfort, outdoor thermal comfort  
- Urban energy and urban design. Energy performance of building quarters and cities, decentralized urban energy production and storage technologies, district heating networks, optimization of energy consumption at district level, effect of the micro climate, urban heat islands, and climate change on the energy performance of buildings and building blocks.  
- Wind driving rain (WDR): WDR phenomena, WDR experimental and modeling, wind blocking effect, applications and moisture durability  
- Pollutant dispersion, pollutant cycle: emission, transport and deposition, air quality  
- Urban acoustics. Noise propagation through the urban environment, meteorological effects, urban acoustic modeling, noise reduction measures, urban vegetation |

Lecture notes

All material is provided via the website of the chair (www.carmeliet.arch.ethz.ch/Education/).

Literature

All material is provided via the website of the chair (www.carmeliet.arch.ethz.ch/Education/).

Prerequisites / notice

No prior knowledge is required.

051-0765-16L Building Process: Economy

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Number of participants limited to 40.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The demonstration of economic considerations within the design and construction process of buildings is the main focus of the diploma elective subject.</td>
</tr>
<tr>
<td>Objective</td>
<td>To grasp the coherences of costs, income and income return.</td>
</tr>
<tr>
<td>Content</td>
<td>The demonstration of economic considerations within the design and construction process of buildings is the main focus of the diploma elective subject. Alongside determining basic principles, case studies play an important role in teaching. The economic factors of building construction are examined and the specific decision process is simulated. The case studies in the lectures as well as the processing of individual topics within the framework of elective work permit and require students active participation.</td>
</tr>
</tbody>
</table>
| Lecture notes | Bauökonomie ("construction economics"), Ausgabe 1.5  
Lecture script for students of architecture, ETH Zurich, spring 2010  
Chair of Architecture and Building Process (ed.), Manfred Nussbaum |
| Literature | - "Economic model for real estate development"  
http://www.bauoek-modell.ethz.ch |

Enrolments of students not showing up on 17.9.15 are deleted without delay.

063-0117-16L Theory of Architecture II: Architectural Theories of the 20th Century Today

<table>
<thead>
<tr>
<th>Analysis</th>
<th>The lecture course discusses the relevance of 19th- and 20th-century theories of architecture for present-day architectural practice. Theoretical issues will be analysed in context of their historical contingencies, present-day buildings confronted with historical ones. Spring semester (Architectural theories of the 19th century today) and autumn semester (Architectural theories of the 20th century today) can be attended independently. During autumn semester, topics include urbanism; organic architecture; modern architecture; technicism; anthropology; semiotics and structuralism; deconstruction, postmodernism, post-structuralism; Marxism and critical regionalism; globalisation and postcolonialism; anthropology and material culture.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Understanding of historical and political contingencies of theoretical issues in architecture.</td>
</tr>
<tr>
<td>Objective</td>
<td>The lecture course, divided into two semesters, discusses theories of architecture of the last two centuries in view of current architectural practice. Theoretical issues will be analysed in context of their historical contingencies, present-day buildings confronted with historical ones. Spring semester (Architectural theories of the 19th century today) and autumn semester (Architectural theories of the 20th century today) can be attended independently. During autumn semester, topics include urbanism; organic architecture; modern architecture; technicism; anthropology; semiotics and structuralism; deconstruction, postmodernism, post-structuralism; Marxism and critical regionalism; globalisation and postcolonialism; anthropology and material culture.</td>
</tr>
<tr>
<td>Content</td>
<td>The lecture course, divided into two semesters, discusses theories of architecture of the last two centuries in view of current architectural practice. Theoretical issues will be analysed in context of their historical contingencies, present-day buildings confronted with historical ones. Spring semester (Architectural theories of the 19th century today) and autumn semester (Architectural theories of the 20th century today) can be attended independently. During autumn semester, topics include urbanism; organic architecture; modern architecture; technicism; anthropology; semiotics and structuralism; deconstruction, postmodernism, post-structuralism; Marxism and critical regionalism; globalisation and postcolonialism; anthropology and material culture.</td>
</tr>
</tbody>
</table>

063-0313-16L History of Art and Architecture V: Architecture and the W

<table>
<thead>
<tr>
<th>Analysis</th>
<th>History of the Future</th>
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</thead>
<tbody>
<tr>
<td>Objective</td>
<td>History of the Future</td>
</tr>
<tr>
<td>Content</td>
<td>History of the Future</td>
</tr>
</tbody>
</table>

No prior knowledge is required.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>063-0315-16L</td>
<td>History of Art and Architecture V: America</td>
<td>W</td>
<td>1 credit</td>
<td>P. Ursprung</td>
<td>The students learn how the design and planning of cities can be evidence based by using scientific methods. The teaching unit conveys concepts of the recent architecture and art history that have an ongoing influence on contemporary architecture.</td>
</tr>
<tr>
<td>063-0353-16L</td>
<td>Construction History: Bâtir la ville du 19ème siècle:</td>
<td>W</td>
<td>4 credits</td>
<td>S. Holzer</td>
<td>Paris plays a key role in the European imagination since the 18th century. The lecture follows this issue in discussing examples of important Parisian buildings.</td>
</tr>
<tr>
<td>063-0371-16L</td>
<td>History and Methods in Building Research</td>
<td>W</td>
<td>4 credits</td>
<td>S. Holzer</td>
<td>The participants will acquire an in-depth understanding of 19th century construction history, between neo-classical and classical modernism, from contemporary treatises to preserved monuments, and including modern challenges of preservation.</td>
</tr>
<tr>
<td>063-0417-16L</td>
<td>Architecture and Structure</td>
<td>W</td>
<td>2 credits</td>
<td>J. Schwartz</td>
<td>The course is centered around a design exercise where the form should be the result of a structural design implemented in an architectural design, combined with a deep knowledge of architectural space.</td>
</tr>
<tr>
<td>063-0419-16L</td>
<td>Experimental Explorations on Space and Structure</td>
<td>W</td>
<td>3 credits</td>
<td>J. Schwartz</td>
<td>In recent decades, new methodologies have emerged in architectural design that exploits the implementation of different parameters as generators of the design concept. Building on the programmatic idea of the Chair of Structural Design of reconciliation of the disciplines of engineering and architecture, the course experiments with the application of design methods that integrate structural and spatial principles from the early stages of the design process. These methods are based on simple geometrical rules that relate spatial and structural parameters. The experimental process will be carried out through the development and construction of physical and digital models. This will allow for the exploration of the permeability of the boundary between the physical and the digital realm.</td>
</tr>
<tr>
<td>063-1357-16L</td>
<td>Digital Urban Simulation</td>
<td>W</td>
<td>4 credits</td>
<td>E. Tapias Pedraza</td>
<td>In this teaching unit architectural and urban design are analyzed by current computational methods. Based on these analyses the effects of planning can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of these correspondent methods in early planning phases.</td>
</tr>
<tr>
<td>063-0311-16L</td>
<td>Transitional Periods: Political Iconology - Architecture in Central Europe 1450-1800</td>
<td>W</td>
<td>1 credit</td>
<td>M. Gnehm</td>
<td>In a series of theory lectures we explore how the design and planning of cities can be evidenced using scientific methods. By various exercises the students are equipped with skills in modern software systems. In an integral project work knowledge in state-of-the-art and emerging spatial analysis and simulation methods is deepened. Based on the imparted methods the effects of planning and design interventions can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of the corresponding computational methods in early planning phases.</td>
</tr>
</tbody>
</table>
The lecture course discusses issues of architecture as a bearer of political meaning in central Europe from 1450 to 1800.

Understanding of political contingencies in architecture and its history.

The notion "central Europe" is a highly politicised geographical term in historiography. During the period in question (1450-1800) the history of central Europe is primarily the history of the Holy Roman Empire and the House of Habsburg. Although the huge area was shaped by the Habsburg idea of empire, it was characterized by the particularistic sovereignty of the many territorial lords. Religious wars further complicated the situation. The lecture course analyses with regard to political and historical changes to what extent secular and sacred buildings in Germany, the Czech Republic, Croatia, Poland, Hungary, Switzerland, and Austria could assume functions as a bearer of political meaning.

851-0252-08L Cognition in Studio Design - Analytic Tools for Evidence-Based Design

Abstract
How can Behavioral and Cognitive Science inform architecture? In this project-oriented course, students are introduced to cognitive and analytical methods to evaluate their design projects. Existing theories are introduced and complemented with hands-on sessions, in which students learn how to implement a range of methods. The course is tailored for students from relevant design studios.

Objective
Taking the perspectives of the end user (occupants and visitors) is vital for a human-centered design approach. Students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to address human cognitive and behavioral needs in built environments. The foundations of environmental psychology and human spatial cognition will be introduced. A focus of the course will be how people perceive their surroundings and orient in space. Students will learn about a range of methods including real-world observation, and methods of architectural analysis such as space syntax. Students will also be exposed to behavior simulation in design, virtual reality experiments, and eye-tracking. Students will reflect the roles of designers and other stakeholders with respect to human-centered design as well as an evidence-based design perspective. The course is tailored for students from a relevant design studio. Upon registering, students should send an email about their design studio to b emo@gess.ethz.ch. As an alternative to obtaining D-GESS credit, architecture students can obtain course credit in "Vertiefungsfach" or "Wahlfach".

051-0317-16L History of Art and Architecture: Architecture and Climate Change (P. Ursprung)

Abstract
This seminar will investigate intersections between architecture and climate change, one of the defining phenomena of our age. We will begin to map out the spectrum of manners in which architecture already engages with this vast and highly unsettling topic as well as how they might be more fully interrogated, invented, and instituted. For any questions, please contact Dr. Emily Eliza Scott (emily.scott@gta.arch.ethz.ch).

Objective
Students should come away with a clearer sense of the stakes of climate change for architecture and of architecture for climate change, as well as a deepened familiarity with relevant projects from the present and recent past.

The discipline of architecture has been slow to engage with the vast and highly unsettling topic of climate change in ways beyond the technical (e.g., new materials, efficiency standards) despite the fact that issues of a social, political, economic, ethical, and even existential order are also, if not foremost, at root and at stake. Our own class discussions will indeed wrangle with a set of unwieldy and interrelated questions, including: At what scales does architecture intersect with climate change? Are planetary and highly local scales newly entwined and, if so, how might architecture respond to and elucidate this condition? Which skills do architects bring to the table, and what is their revised role, in light of this accelerating and encompassing phenomenon? Does climate change demand a reimagining of the field? What would architecture look like that, rather than sheltering us from our surroundings, instead served as an interface between the two—orienting itself toward the human and nonhuman at the same time?

With a focus on the contemporary but eye to the recent past, we will begin to map out the spectrum of manners in which architecture has already engaged with climate change as well as how these might be more fully interrogated, invented, and instituted.

Class will meet for three hours each week, comprising a lecture, discussion, and student presentations. Over the course of the semester, there will also be multiple inputs by guest speakers, a field trip, and graded exam.

Lecture notes
A syllabus, required readings, and other course materials will be published/downloadable from the website of Professor Ursprung's chair at the beginning of the semester.

Literature
For further information, including literature, see: http://www.ursprung.arch.ethz.ch/lehreferenstaltungen

Prerequisites / notice
All lectures, readings and discussions will be held in English. If you wish to participate in the course, attendance at this first meeting is compulsory. For any questions, please contact Dr. Emily Etiza Scott (emily.scott@gta.arch.ethz.ch).

103-0569-00L European Aspects of Spatial Development

Abstract
Following the insight into historical perspective and contemporary models of governance and planning, the course focuses on the relevance of European transnational cooperation for spatial planning. This includes a discussion of how European spatial policy is made and by whom, how planners can participate in such process and how they can address transnational challenges of spatial development cooperatively.

Keeping the general aim of exploring the European dimension of spatial planning in mind, the specific course learning objectives are as follows:
- to interpret the history of spatial planning at the transnational scale
- to understand and explain the content of the European spatial policy agenda
- to describe and analyse the role of territorial cooperation in making European spatial development patterns and planning procedures
- to discuss the changing role of planners and evaluate the ways of their engagement in European spatial policy-making

- European spatial policy agenda: introduction and basic directives
- governance models
- planning models; collaborative planning model (main concepts & critics)
- post-positivist approach to spatial planning
- transnational spatial planning in Europe; questioning the European spatial planning; spatial development trends in Europe
- EU as a political system: EU institutions & non-EU actors
- planning families in Europe; the European spatial planning agenda
- spatial planning strategies and programmes on territorial cooperation
- the notion of planning culture and planning systems; planning cultures in Europe
- basic characteristics of planning systems in Europe
- the relevance of European transnational cooperation for spatial planning
- European transnational initiatives: CODE 24 (Rotterdam-Genoa), Orient-east-Med corridor (Hamburg-Athens), Danube region

Learning outcomes
The documents for the lecture will be provided at the moodle, https://moodle-app2.let.ethz.ch/course/view.php?id=2298.
The medium of performance art is the human being, whose voice and body send out messages into surrounding society. Performance art

Type

Spatial Concepts in Film and Architecture (Prof

The objective of the course is twofold: On the one hand, students will get to know and to apply a critical approach to architecture by means

D. E. Agotai Schmid

2 credits

New perceptions of architecture are studied on behalf of film analyses and experimental topics. During the course space-effective creative

1 credit

Performance and Intervention

D. E. Agotai Schmid

2 credits

The seminar investigates the potential and the limitations of architectural criticism. The course comprises theoretical reflection, discussions

S. Keller Roca

2 credits

Prerequisites / notice

The seminar is structured in three sections. In a first step, theoretical foundations will be established based on reading and discussing

Involves additional fees.

- Commission of the European Communities. (1997). The EU compendium of spatial planning systems and policies. Luxembourg: Office

-    Commission of the European Communities. (1997). The EU compendium of spatial planning systems and policies. Luxembourg: Office

-    Commission of the European Communities. (1997). The EU compendium of spatial planning systems and policies. Luxembourg: Office

-    Commission of the European Communities. (1997). The EU compendium of spatial planning systems and policies. Luxembourg: Office

Hours

S. K. Keller Roca

Data: 06.11.2018 12:57

Autumn Semester 2016

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Since the mid 19th century the representation of architecture is inextricably linked to photography. Many buildings are being discussed on the basis of photographs. The artist and photographer Tobias Wootton (HfG Karlsruhe) will teach the students the various techniques (large scale, medium format, small format, digital photography).

Enrolment in agreement with the lecturer. A motivation letter has to be sent until Friday 16th September 2016, 12 h.

### 051-0199-16L

**Architecture and Photography**

**W** 2 credits 2S  T. Wootton

**Abstract**

A motivation letter is to send to wootton@arch.ethz.ch until Friday 16th September 2016, 12 h.

**Objective**

Since the 20th century the representation of architecture is inextricably linked to photography. Many buildings are being discussed on the basis of photographs. We will approach the prelinguistic space of artistic thinking and agency from its context, which supports, mediates, criticizes, sells and preserves its artworks. We listen to the various protagonists of this space - cultural agents in civil service institutions, art mediators, critics, curators, gallerists, custodians; for in this space surrounding the prelinguistic one, nothing is left to chance.

**Content**

The department of Architecture and Fine Arts has a 3D bodyscanner available for the digitalization of persons and objects, and is complemented by a special software for modeling the 3D data. After a period of training and practice, participants are asked to develop ideas and concepts for their own projects. These concepts should be used to lead and expand the system and the possibilities of its application. The process of readjustment and its realization will be a continual part of developing the individual projects.

**Prerequisites / notice**

The number if participants is limited to 14 students and enrolments need the lecturer’s allowance! We Works with a 3D Touch Mouse, see Youtbe https://www.youtube.com/watch?v=NfF7nfkte2Q

### 051-0201-16L

**3D Scanning and Freeform Modeling**

**W** 2 credits 2U  K. Sander

**Abstract**

Digital Sculpture. Experimental use of a system for digitalizing and modeling 3D objects.

**Objective**

Experimentation with digital tools and various design processes of 3D forms in fine arts, design and architecture. Practicing and playing with dimensionality and sense of space.

**Content**

The department of Architecture and Fine Arts has a 3D bodyscanner available for the digitalization of persons and objects, and is complemented by a special software for modeling the 3D data. After a period of training and practice, participants are asked to develop ideas and concepts for their own projects. These concepts should be used to lead and expand the system and the possibilities of its application. The process of readjustment and its realization will be a continual part of developing the individual projects.

**Prerequisites / notice**

The number if participants is limited to 14 students and enrolments need the lecturer's allowance! We Works with a 3D Touch Mouse, see Youtube https://www.youtube.com/watch?v=NfF7nfkte2Q

### 051-0219-16L

**Artistic and Conceptual Thinking and Working**

**W** 2 credits 2S  S. Keller Roca

**Abstract**

We approach the prelinguistic space of artistic thinking and agency from its context, which supports, mediates, criticizes, sells and preserves its artworks. We will discuss the various protagonists of this space - cultural agents in civil service institutions, art mediators, critics, curators, gallerists, custodians; for in this space surrounding the prelinguistic one, nothing is left to chance.

**Objective**

This seminar aims at providing access to the prelinguistic space of artistic thinking and agency, in order to be able to observe the artists in their immediate working process. This space can only be entered if we successfully leave all layers of mediation behind us and cease to force an understanding.

**Content**

The seminar, of course, with its claim to teach the critical faculty to be astonished, is also part of these layers of mediation. We will measure this paradox of art directly up against our own ambitions. A productive tension will be established within us when we open up to artistic practices potentially contradicting our own.

**Literature**

Brian O’Doherty: Inside the White Cube. The Ideology of the Gallery Space. When these essays first appeared in Artforum in 1976, their impact was immediate. They were discussed, annotated, cited, collected, and translated; the three issues of Artforum in which they appeared have become nearly impossible to obtain. Having Brian O’Doherty’s provocative essays available again is a signal event for the art world. This edition also includes “The Gallery as Gesture,” a critically important piece published ten years after the others.

**Prerequisites / notice**

The number of participants is limited.

Application for the course with the lecutrer also via e-mail: stefan.keller@arch.ethz.ch

### 051-0223-16L

**Free Drawing**

**W** 2 credits 2U  Z. Leutenegger Küng

**Abstract**

Against the background of my self-developed ten-line-format we are going to discover thematically partly fee, partly architecture related topics, by writing.

**Objective**

Structure and/or strengthening of the capability to express oneself in writing on a journalist level - effortlessly, flexibly and easily , thus primarily on special guidelines with regard to a tight text volume (i.e. blursbs on books or short contributions in magazines).

**Content**

The seminar enables students to work out concise and coherent texts of high linguistic expression to various topics within very short time.

**Literature**

Mohafez, Sudebah: das zehn-zeilen-buch; Dresden 2016 (2010)
Queneau, Raymond: Stilübungen; Frankfurt am Main 1990 (1947)

**Prerequisites / notice**

Enrolment on agreement with the Assistant, Ms. Sudebah Mohafez mohafez@arch.ethz.ch.

*****

**Autumn Semester 2016**

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**Data: 06.11.2018 12:57**
### 051-0227-16L

**Architectural Drawing**  
Number of participants limited to 136  

<table>
<thead>
<tr>
<th>Level</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>2</td>
<td>The number of participants is limited.</td>
</tr>
<tr>
<td>2G</td>
<td></td>
<td>Application for the course with the lecuturer also via e-mail: Zilla Leutenegger <a href="mailto:leutenegger@arch.ethz.ch">leutenegger@arch.ethz.ch</a></td>
</tr>
</tbody>
</table>

**Abstract**  
With the architectural drawing we can refer to one of the most important and primary design tools. Imaginations, ideas, as also the observation of important scenarios and impressions could be visualized with the appropriate technique.

**Objective**  
Based on the process of the concrete, practical drawing, we can sensitize our perception and enhance also the interaction between head and hand. Also the digital drawing with Wacom tablet (if available) should not be missed out as an additional challenge.

**Content**  
The focus of the drawings are determined in the study of architectural references as: figure, plasticity, body, space, light, atmosphere, etc.

**Prerequisites / notice**  
The number of participants is limited by 136.

### 051-0235-16L

**Theory of Architecture: Curating 1917 - The Architecture of Russian Revolution (a.i. Moravanszky)**  

<table>
<thead>
<tr>
<th>Level</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>2</td>
<td>This is not a lecture course. Attendance and active participation is required. There will be weekly mandatory reading and creative assignments (expect circa two hours per week of homework).</td>
</tr>
<tr>
<td>2S</td>
<td></td>
<td>Enrolment limited to 20.</td>
</tr>
</tbody>
</table>

**Abstract**  
In the course of this seminar, we will collectively prepare the exhibition "The Architecture of Russian Revolution" (included in the "gta 50" exhibition series, to be open in February 2017).

**Objective**  
To commemorate the 100-year anniversary of the Russian revolution (1917), this seminar examines the impact of the political revolution upon architectural education. We focus on teaching architecture at Moscow Higher Art and Technical Studios (VKhUTEMAS; 1920-1927), a school that rivalled the Bauhaus as one of the earliest and most important "avant-garde" architectural institutions. This experimental-format seminar will serve as a preparation for the exhibition "The Architecture of Russian Revolution," which will open in February 2017 a part of the series of exhibitions devoted to the 50th anniversary of the gta (Institute for the History and Theory of Architecture at ETHZ). The exhibition's particular focus will be on the importance of VKhUTEMAS legacy for architectural pedagogy (especially, at ETHZ) today.

Collectively, we will develop the concept of the exhibition and make curatorial and installation decisions.

**Content**  
The Russian Revolution (1917) dramatically changed not only political system, but also the lifestyle and culture in the country, including approaches to architectural education. Student protests against old, academic system of education followed the revolution, leading to a creation, in 1920, of one of the earliest "avant-garde" architectural institutions, the Higher Art and Technical Studios (VKhUTEMAS) in Moscow.

Instead of the old practice of moving from drawing details to smaller buildings and finally finishing their education by designing a large building, the students now started by analyzing formal elements important for different arts: "Color" served an introduction to painting, "Volume"-to sculpture, "Space"-to architecture, and "Drawing" (that is, line) as an introduction to graphic design. The most developed of the introductory courses, Ladovski's course "Space," analyzed three-dimensional reality as a combination of "elements of sensation": the basic physical, geometrical, and spatial properties of form, such as mass, volume, gravity, or dynamics. This course will be at a particular focus of our attention. We will approach it from a variety of contexts: the political situation in the aftermath of the Revolution; the changes in Russian culture and society; the developments in science (in particular, experimental psychology) and the new concept of the human that they entailed; the emergence of modernist approaches to architecture and its pedagogy; the challenges that these changes and developments posed for architectural education. As a result of our study, we will develop the concept of an exhibition on VKhUTEMAS and its importance for architectural pedagogy today.

**Prerequisites / notice**  
The number of participants is limited by 136.

### 051-0621-16L

**Architecture and Digital Fabrication**  
Limited number of participants.

<table>
<thead>
<tr>
<th>Level</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>4</td>
<td>The script is provided by the teaching chair and can be purchased the day the elective course starts.</td>
</tr>
<tr>
<td>4G</td>
<td></td>
<td>Limited places (enrolment on lecturer's acceptance only).</td>
</tr>
</tbody>
</table>

**Abstract**  
Advance in technology revolutionizes design and fabrication processes within architecture. Digital fabrication allows immediate production from design data. The architect as author of these data takes a key role in this development. This course focuses on strategies for architectural production by means of algorithmic design tools and computer controlled fabrication methods.

**Objective**  
The goal of the Wahlfach is to learn basic approaches to designing with the knowledge about digital fabrication techniques and their creative application within a specific task.

**Content**  
We use the term digital materiality to describe an emergent transformation in the expression of architecture. Materiality is increasingly being enriched with digital characteristics, which substantially affect architectures physis. Digital materiality evolves through the interplay between digital and material processes in design and construction. The synthesis of two seemingly distinct worlds - digital and the material generates new, self-evident realities. Data and material, programming and construction are interwoven. This synthesis is enabled by the techniques of digital fabrication, which allows the architect to control the manufacturing process through design data. Material is thus enriched by information; material becomes informed. In the future, architects ideas will permeate the fabrication process in its entirety. This new situation transforms the possibilities and thus the professional scope of the architect.

**Lecture notes**  
The script is provided by the teaching chair and can be purchased the day the elective course starts.

**Prerequisites / notice**  
The number of participants is limited to 136.

### 051-0731-16L

**CAAD Theory: A Quantum City - How to Think About Cities**  

<table>
<thead>
<tr>
<th>Level</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>2</td>
<td>The number of participants is limited.</td>
</tr>
<tr>
<td>2G</td>
<td></td>
<td>Application for the course with the lecuturer also via e-mail: Zilla Leutenegger <a href="mailto:leutenegger@arch.ethz.ch">leutenegger@arch.ethz.ch</a></td>
</tr>
</tbody>
</table>

**Abstract**  
What if cities are not connected in space and time? You easily can talk to them. Just by taking a phone for example. But they are species in parallel universes.

**Objective**  
This course will explore the role of computational power and information technologies in the creation of our imaginaries around the city. We will show you how models and theories, emerging mainly during the 19th and 20th centuries, present leaps correspondence with more ancient conceptions of the city, when observed from an informational perspective.
This course will explore the role of computational power and information technologies in the creation of our imaginaries around the city. We will show you how models and theories, emerging mainly during the 19th and 20th centuries, present leapfrogging correspondences with more ancient conceptions of the city, when observed from an informational perspective. We will establish a refreshing dialogue in times where we seem to be overwhelmed by the wide range of possibilities that technology and the abundance of information are opening up. We are bored by the overused debates around urbanization as a threat, energy crisis, climate change, smart cities: the same problematic is elucidated, no matter which city you are looking at. Instead, we will explore the possibilities that the digital has to offer to us, the world citizens. Such transformations have taken place since the very inception of cities, and this is why we are convinced that each era including our own has to reinvent its City within its corresponding cultural galaxys.

After this overall general presentation and in order to have a closer look to specific aspects of sustainability, students will work in groups and assess during one or two weeks this specific criteria on one of the case studies presented before. This practical hands on the label will be presented and explained by experts. Different certification schemes, including LEED (American standard), DGNB (German Standard with Swiss adaptation), SNBS, MINERGIE-ECO and 2000-Watt-Society (Swiss standards) will be presented and explained by experts.

Throughout this tutorial we will learn to code in Python and further learn to put together a number of custom-made and open source algorithms in order to operate the web programmatically.

Attendance is compulsory and will be controlled.

<table>
<thead>
<tr>
<th>051-0733-16L</th>
<th>CAAD Practice: Bots, Characters &amp; Architecture</th>
<th>W</th>
<th>2 credits</th>
<th>2G</th>
<th>L. Hovestad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Computers and computer networks provide today a new kind of mobile and instant operability; a user's reach of action increases dramatically by having access to a computer online. Computer networks emit, receive, store and process information at the speed of light, in vast quantities, and regardless of the content.</td>
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<tr>
<td>Objective</td>
<td>Broadly, the aim of this course is to program 'computational objects' capable to operate data-streams in order to challenge different notions of information, model, computation, design, complexity, authorship, analysis, synthesis, ontology, causality, or semantics, i.a., that are arguably relevant to the field of architecture.</td>
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<tr>
<td>Content</td>
<td>You have probably noticed how Spotify is able to programatically put together a weekly list with songs that you most probably will like; or how Netflix endlessly suggests you interesting tv shows to watch. This phenomenon is increasingly around us, instantaneous and accurate suggestions of natural things. But what happens if we want to compare things from different natures? Could we ask, for instance, for indexes to literature, music or food based on our preferences for certain architecture?</td>
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</table>
| Literature   | CAAD Practice: Bots, Characters & Architecture |}

<table>
<thead>
<tr>
<th>051-0203-16L</th>
<th>360° - Reality to Virtuality</th>
<th>W</th>
<th>4 credits</th>
<th>4G</th>
<th>K. Sander, A. Wieser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Basics of 3D-scanning of rooms and bodies, individual scan projects, 3D-visualizations and animations. Working alone and in groups.</td>
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<tr>
<td>Objective</td>
<td>Understanding of 3D-technologies, handling positive and negative spaces, handling hardware and software, processing 3D-data (registering of scans, precision, interconnecting, filtering, visualizations and animations), interpretation of the generated data.</td>
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<tr>
<td>Content</td>
<td>1. Introduction in hardware and software (getting to know technologies and context, administer tests)</td>
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<tr>
<td>Notice</td>
<td>2. Project development within group (idea, concept, target, intention, election of methods, strategies)</td>
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<tr>
<td>Notice</td>
<td>3. Project implementation within the group (possible results, videos, pictures, prints, publications, web, blog, forum etc.)</td>
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<tr>
<td>Notice</td>
<td>4. Project presentation (exhibition incl. critiques, discussions)</td>
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<tr>
<td>Notice</td>
<td>Attendance is compulsory and will be controlled.</td>
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</table>

#### Construction / Building Technology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0587-00L</td>
<td>Workshop on Sustainable Building Certification</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>D. Kellenberger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Number of participants limited to 25</td>
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<tr>
<td>Objective</td>
<td>Building labels are used to certify buildings and neighbourhoods in term of sustainability. Many different labels have been developed and can be used in Switzerland (LEED, DGNB, SNBS, Minergie). In this course the differences between the certification labels and its application on 3 emblematic case study buildings will be discussed.</td>
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<tr>
<td>Content</td>
<td>After this course, the students are able to understand and use the different certification labels. They have a clear view of what the labels take into consideration and what they don't.</td>
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</tr>
<tr>
<td>Literature</td>
<td>All documents for certification labels as well as detail plans of the buildings will be available for the students.</td>
<td></td>
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</tr>
</tbody>
</table>

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 110 of 1571
**Building Physics: Moisture and Durability**

**W** 3 credits  2G  J. Carmeliet, T. Defraeye

**Abstract**
- Basic knowledge of moisture transport and related degradation processes in building and civil engineering materials and structures; concepts of poromechanics and multiscale analysis; analysis of damage cases.
- Introduction to concepts of poromechanics and multiscale analysis
- Application of knowledge by the analysis of damage cases

**Objective**

**Content**

1. Introduction
- Moisture damage: problem statement
- Durability

2. Moisture Transport
- Description of moisture transport
- Determination of moisture transport properties
- Hysteresis
- Transport in cracked materials
- Damage and moisture transport in cracked media

3. Poromechanics
- Moisture and mechanics: poro-elasticity
- Poro-elasticity and salt crystallisation
- Poro-elasticity and damage
- Case studies

4. Multiscale analysis
- Problem statement
- Multiscale transport model
- Multiscale coupled transport - damage model

**An Introduction to Sustainable Development in the Built Environment**

**W** 3 credits  2G  G. Habert

**Abstract**
This year the UN Conference in Paris will shape future world objectives to tackle climate change. This course provides an introduction to the notion of sustainable development when applied to our built environment.

**Objective**
At the end of the semester, the students have an understanding of the term of sustainable development, its history, the current political and scientific discourses and its relevance for our built environment.

**Content**
In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environmental aspects.

The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.

Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.

After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.

The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.

**Literature**
A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

**Negotiating Structural Forms: History of Structural Design**

**W** 2 credits  2G  J. Schwartz

**Prerequisite:** Successful completion of Structural Design I-IV.

**Abstract**
Dealing with the structural necessity against the background of the formal intent often lead, besides discourses, to architectural and technical enrichment as well as unique buildings. This seminar focuses on the work of key figures, that will be discussed on the basis of texts, concepts and buildings.

**Objective**
Getting to know key designers on the borderline between architecture and structural engineering, their positions, concepts and most important buildings.

**Content**
Seminar focusing on the discussion of important essays and buildings of distinguished builders and architects on the basis of short presentations, models, input lectures and invited guests, as well as films and excursions.

**History, Theory and Methods in Historic Building**

**W** 2 credits  2G  to be announced
Abstract
Timber and metal structures
(historical development, manufacturing technology, documentation and evaluation, historic building conservation)

Objective
Timber and metal structures
(historical development, manufacturing technology, documentation and evaluation, historic building conservation)

Content
Timber and metal structures
(historical development, manufacturing technology, documentation and evaluation, historic building conservation)

051-0763-16L
New Focal Points of Construction

**Abstract**
The elective subject "New focal points of construction" investigates the complex interaction of construction elements by means of exemplary architectonic tender points such as base, wall, chamber, roof etc.

**Objective**
Target of the course is the understanding of the impacts of material, technology and construction to the architectural education of constructive points. With comparative analysis of built constructions serves as a basis for further development of hypothetical future constructions.

Content
Lecture:
1. Comparative analysis for derivation and understanding of the constructive points base, wall, chamber, roof etc.
2. Description of current level of technique, typical methods, and set of problems.
3. Final colloquia with guests of producing and processing companies.

Exercise:
New formulation of a future constructive point as a result of a diagnostic work.

051-0777-16L
Building Process: Realization

**Abstract**
Visits to construction sites and interdisciplinary lectures on the topics of communication, complexity, landscape and investment are the main focus of the workshop. In addition, the term process is to be depicted by means of visits to manufacturers of construction components.

**Objective**
The main focus of the diploma elective subject is in showing the building process by means of current examples of urban design with architectural relevance. The Chair views itself as the facilitator between those involved in construction and students. Active participation is a prerequisite.

**Content**
The main focus of the diploma elective subject is in showing the building process by means of current examples of urban design with architectural relevance. Visits to construction sites and interdisciplinary lectures on the topics of communication, complexity, landscape and investment are the main focus of the workshop. In addition, the term process is to be depicted by means of visits to manufacturers of construction components. The Chair views itself as the facilitator between those involved in construction and students. Active participation is a prerequisite.

**Literature**
Sacha Menz (Hrsg.), Drei Bücher über den Bauprozess, vdf Hochschulverlag an der ETH Zürich, 2009
Literaturrempfehlungen unter www.bauprozess.arch.ethz.ch

**Prerequisites / notice**
The number of participants is limited and enrolment is only possible in agreement with the chair!

051-0781-16L
Costuire correttamente/Constructing Correctly: Curve and Fold to Bear Loads and Forces

**Abstract**
In line with the approach of P.L. Nervi's book, our study is based on factors that, outlined by him, are still today all the more relevant as a lesson for architecturally and structurally justified buildings. His thoughts represent valuable criteria and indispensable tools for observation and carrying out investigations of the built environment.

**Objective**
"Costuire correttamente" (Constructing Correctly), the 1955 book published by Pier Luigi Nervi, covers crucial factors for building that, outlined by him, are still today all the more relevant as a lesson for architecturally and structurally justified buildings. His thoughts represent valuable criteria and indispensable tools for observation and carrying out investigations of the built environment.

**Content**
The main thread of this course, that runs over two semesters (*), are buildings of all ages that could be categorised under notions such as "most viewed", "most technically daring", "most unknown", "most discussed" or "most worthy of discussion", and carry instructive aspects of the teachings of Pier Luigi Nervi ("costuire correttamente"). In the lecture, these buildings will be investigated on-the-spot, described from the designers' point-of-view and will be commented on with reference to any redesign resulting from the interplay of architectural and structural concepts. Harmonies and disords should be discovered.

Occasionally there will be guest lectures. These people, who were directly involved with a certain building, will portray the emergence and development of the project. In this sense, the course is also intended for civil / structural engineering students and presents a possible bridge between the two prospective project partners - architect and engineer.

(*) Begins in the autumn semester. Entry into the course in the spring is possible.

Lecture notes
None for the time being

051-0823-16L
Material-Workshop

**Abstract**
The elective is organised as a laboratory where one particular material will be explored on a theoretical and practical level. During this study the contemporary architectural potential of the material will be tested and applied.

**Objective**
Experience, know-how and interest are the basis to explore a material and develop new ways to construct and form architecture. The objective of this course aims at exploring the correlation between material, construction and architectural expression.

**Content**
The elective is organised as a laboratory where one particular material will be explored on a theoretical and practical level. During this study the contemporary architectural potential of the material will be tested and applied.

**Prerequisites / notice**
http://www.spiro.arch.ethz.ch/de/lehre/wahlfach-materialwerkstatt.html

051-0855-16L
Masterclass Construction: Steelwork

**Abstract**
The number of participants is limited to 24.

**Objective**
The number of participants is limited to 20

**Content**
The elective is organised as a laboratory where one particular material will be explored on a theoretical and practical level. During this study the contemporary architectural potential of the material will be tested and applied.
The course aims for an ability to understand concepts of sustainable building technology coherently integrated into an architectural design.

The goal of this elective course is to explore the perception, use and representation of landscape through the use audiovisual tools. In this course, we will map the landscape above the new Gotthard Base Tunnel with sound recorders and photo cameras, and landscape interventions.

The City of Zurich rises there where Celtic tribes settled and the Romans founded a city. In the past two millennia authorities, planners of different disciplines, merchants and craftsmen, institutions and investors have shaped the city upon the Limmat. The physical outcome of these interventions stand in close relationship with the knowledge of the time and reflect the prevailing positions and theories, which were thought, published and built elsewhere. For that matter, the history of urban design of Zurich can be well understood as a branch of the history of European urban design, as well as the individual steps of development are offsprings of international reflexions and tendencies. Presentations in the seminar room and the visit of the selected ensembles in Zurich will help to tell the story of the urban development from the Middle Ages up to today. With this basic knowledge gained in the seminar and the walks the students will have to discuss the historical theories and developments as well as the urban qualities of the ensembles. This will help the students to better understand the city but will also allow them to sample different urban situations and gather spatial experiences, which can also facilitate their design process.

Limited number of participants (limitation due to technical equipment).

We will discover the audiovisual qualities of the mountain landscape, map our overground "tunnel journey" with sound recorders and photo cameras, and intervene in the environment at vertical points of intersection. How is our perception on the surface shaped through the awareness of the tunnel below? How do we experience the vast and lonesome mountain area at a walking pace instead of rushing through it in a secure enclosure? Using techniques from sound art, land art and "strollology", we want to examine the Gotthard, understood as both archaic nature and cultivated alpine landscape, a high-tech transit area and a pre-modern refuge, the "center of Europe" and the periphery of Switzerland.

Back in our AudioVisual Lab, we will work with audio editing tools, spatial sound design and photographic processing in order to compose a collective multisensory map of the Gotthard.

The focus lies on LowEx-systems.

The number of participants is limited to 24 persons.

The prospective architect shall develop necessary skills to be able to think construction in its complex relationships and to face future discussions in practice competently.

The structure of the course contains:
1. Impartation of basic knowledge of construction
2. Seminar / exercises on the state of technology / research
3. Integration of practical case studies and problems

Enrolment on agreement with lecturer only.

The number of participants is limited to 24 persons.
The term ‘paradise’ and its religious implications originate from ‘pairi-daeza’, Old Persian for ‘a wall surrounding a garden’. The elective course serves as an introduction to landscape architectural design on various scales including the topics of border, threshold, water, vegetation, topography, choreography, and metaphor. Architecture students develop a project based on the perception of place, knowledge of landscape-architectonic typologies, and conception of public space. They become familiar with GIS as an analytical tool, model building as a design methodology and the representation of landscape through plans. The design process is accompanied by workshops, lectures, excursions, critiques and a workbook.

Enrolment in agreement with the lecturer only.

Limited number of participants. The course is fully booked!

Enrolment after Agreement only!

THE COURSE IS FULLY BOOKED!

Introduction to the workshop week in February 2017:
5th December 2016, 6 pm, HIL H 40.9.

Workshop week: 6th to 14th February 2017:
Trip to Ljubljana: 6th to 9th of February 2017;
Final critiques: 14th February 2017.

Enrolment in agreement with the lecturer only:
Roland Shaw shaw@arch.ethz.ch

Limited number of participants. The course is fully booked!

Enrolment in agreement with the lecturer only: Roland Shaw shaw@arch.ethz.ch

Enrolment after Agreement only!

THE COURSE IS FULLY BOOKED!

Enrolment in agreement with the lecturer only: Roland Shaw shaw@arch.ethz.ch

Enrolment after Agreement only!
"What is the ideal city (...) that best expresses the power and beauty of modern technology and the most enlightened ideas of social justice?" - asks Robert Fishman in his opus, Urban Utopias in the Twentieth Century (1977). For Fishman, Ebenezer Howard's Garden City (1898), Le Corbusier's Ville Radieuse (1924) and Frank Lloyd Wright's Broadacre City (1932) stand out among utopian projects for their radically original urban designs, their revolutionary program for social change, and their authors' sustained personal commitment to realize the plans. Besides these ideal cities, Fishman suggests that utopian projects fall into two further categories: they are either utopian romances, that is, technical exercises without explicit social agenda, such as the technological utopias of Archigram or Yona Friedman; or urban ideologies, that is, projects that might bear social content but could still be carried out without revolutionary social change, as they tend to preserve an already powerful class. Such are designs produced by totalitarian regimes or dictated by powerful market conditions.

Following Fishman's theoretical grid, we will read excerpts from each of his rubrics, while considering utopian design thinking within a broader and more fundamental discussion about the means and ends of urban design. Kevin Lynch asserts that the purpose of urban design is the 'good city' (1981). What is then the role of utopias in achieving this goal? While exploring this question, we will also confront utopias with critical approaches that could be described as pragmatic. Jane Jacobs, for example, argues that utopias demand totalitarian control, whereas urban neighborhoods should be developed and rejuvenated employing bottom-up approaches.

We will ultimately link the studied concepts with various urban forms, such as the megaraster in relation to technological utopias or the Manhattan block in Rem Koolhaas' interpretation. In his book Finding Lost Space (1986) Roger Trancik identifies three major approaches to theories of urban form: the figure-ground, linkage, and place theories. We will classify each of the discussed forms into the above three categories. Thus, we will wrap up the class with a basic grid on form theories - after having started it with another one regarding utopian visions.

After an introductory lecture, we will discuss one edited text each week, and confront the different positions they represent with each other. Accordingly, participants will be expected to read one text and write a half-page response each week, to once prepare and hold a 15-minute presentation of a text (including a compact handout), and to actively participate in the discussions. Optionally, 10 to 15-page position papers can be written after the semester as elective theses, honored by additional credit points. A reader with selected texts and thematic introductions will be provided.

**Objective**

A reader will be handed out at the intro event of the elective course.

**Prerequisites / notice**

The number of participants is limited to max. 30 students.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>W</th>
<th>G</th>
<th>Literature</th>
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</thead>
<tbody>
<tr>
<td>051-0701-16L</td>
<td>Systematic Principles of Urban Design: Learn from the European City</td>
<td>2</td>
<td></td>
<td>V. Magnago Lampugnani, H. Stühlinger</td>
<td>Lecture notes</td>
</tr>
<tr>
<td></td>
<td>Urban Ensembles of the Modern City. Strategies for Dealing with the Twentieth-Century City</td>
<td></td>
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<td></td>
<td>Literature</td>
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<tr>
<td></td>
<td>The seminar will focus on case studies in order to reveal strategies for dealing with the modern city. Built urban-development ensembles from the twentieth century will be embedded in their architectural and historical context, studied with an eye to their constitutive elements and discussed in connection with current urban-planning projects. In addition to various forms of methodological engagement with urban contexts, students will experience how the disciplines of urban-planning history and urban development can be considered in a more integrated way. Moreover, they will receive feedback on how to present the result of their analyses in concise, well-structured talks and in drawings.</td>
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<td></td>
<td></td>
<td>Literature</td>
</tr>
<tr>
<td>051-0723-16L</td>
<td>Information Architecture and Future Cities: Smart Cities</td>
<td>2</td>
<td></td>
<td>V. G. Schmidt</td>
<td>Lecture notes</td>
</tr>
<tr>
<td></td>
<td>The approach to urban-planning ensembles of the twentieth-century city is characterized by their enormous quantity - which also makes dealing with them more difficult. The building stock dating from this era is immense. There is little discussion currently of how larger spatial contexts - housing estates, neighbourhoods, entire cities - can be not just designed and planned but also continuously developed as overall ensembles. Moreover, strategies, instruments and procedures for dealing with the vestiges of twentieth-century urban planning have yet to be established. In the seminar we will discuss how specific approaches to analysing, assessing and further developing of specific case studies have been formulated and explored recently as well as the extent to which they are experimental and deviate from traditional means for preserving and developing the city. Any discussion of an example of urban planning from the previous century must begin with precise analysis: taking up its original urban-planning principles in their historical dimension and all of the features that affect urban planning. The seminar will emphasise this sort of contextual discussion of modern urban space.</td>
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<td>Literature</td>
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<td>SMART CITIES - What will happen when cities change from static configurations into responsive and dynamic structures? What does it mean for buildings that undergo the same changes? What is the impact on architectural and urban design education? How can citizens influence this development? The SMART CITIES course will answer these questions and supply you with the necessary skills and knowledge to understand and design such dynamic structures. The intelligent use of data and information are at the core of this course. Data and information are new building materials of future cities. Citizens produce increasing amounts of data in their daily life, with stationary sensors and mobile smartphones. Using those data, citizens can influence the design of their cities and the re-design of existing ones. The course will be a first step towards the emerging citizen design science and cognitive design computing. Those will be the next generation of participatory design and design computing.</td>
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<td>Literature</td>
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<td>The necessary texts will be found on the Chair's website at: <a href="http://www.ia.arch.ethz.ch">http://www.ia.arch.ethz.ch</a>. We specifically recommend the consultation of the Future Cities Website at: <a href="http://www.futurecities.ethz.ch">http://www.futurecities.ethz.ch</a> during the entire course. The iBook INFORMATION CITIES is available in the eXtreme Massive Open Online Course (MOOC) Future Cities support the course.</td>
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<td>Prerequisites / notice</td>
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<td></td>
<td>Digital Urban Visualization: People as Flows</td>
<td>2</td>
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<td>V. G. Schmidt</td>
<td>Prerequisite notices</td>
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<td>We examine patterns of crowd-flows in an extraordinary urbanisation phenomena: festivals. The course participants will learn how to program simulations using Processing/Java. Previous programming knowledge is not necessary. Furthermore they will gain insights into other analysis methods and learn about their significance, strengths and weaknesses.</td>
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**Data:** 06.11.2018 12:57  
**Autumn Semester 2016**  
**Page 115 of 1571**
We will look at those patterns from two sides. One being the view of a planer asking to find bottle necks or the ideal place for amenities such as booths, toilets etc. Another being the view of visitors. We will program different behaviours that should compete against each other in order to compare their different strategies. As a case study we will use the Callente Festival in Zurich.

For deepening the learnt in a semester thesis we offer to optimise the created simulations to make them available in interactive planning workshops. Additionally they could be converted into interactive web apps.

http://www.ia.arch.ethz.ch

No programming skills are required.

**051-0815-16L**  
**ACTIONS! On the Real City: Wunderkammer**  
**W**  2 credits  
**2U**  
**A. Brillembourgh, H. Klumpner**

**Abstract**

A full urban block in the center of Opfikon's Glattpark area is the site of intervention for this semester's elective. Students will learn how to develop and realize ideas for rapid change in context of both existing initiatives and future plans. They will negotiate, edit, intervene, and explore the relationship between visionary goals, planning regulations and operational possibilities.

**Objective**

How can we increase urban value through an open and inclusive process? And how can we improve upon current planning paradigms via active experimentation?

The course is run in collaboration with the "Wunderkammer" project, lead by Zurich's very own Jane Jacobs, Vesna Tomse, who is well-known for her ability to rejuvenate public open space through activating bottom-up initiatives. Supported by Stadt Opfikon, the project's mandate is to transform the undeveloped site into an area of opportunity through incremental change and community buy-in.

The course will begin with a voluntary trip to the renaissance castle of Ambras to experience a Wunderkammer firsthand. This will be followed by a guided site visit during which students will be introduced to Glattpark, its recent developments and the Wunderkammer project's ambitions. The first exercise will be to document the potential and hidden qualities of the area. Then, after defining a collective design charter, students will work towards developing on-site physical interventions as decision-making tools. The goal of the studio is to define a more grounded process for community driven design and trigger incremental change. To continue investment in the site, students' work will be showcased at a concluding exhibition and event.

**Collaborators:**  
Vesna Tomse and the Verein Wunderkammer  
www.wunderkammer-glattpark.ch

**Prerequisites / notice**

It is available for students from all disciplines.

Lecturers: Marie Grob, Diego Ceresuela-Wiesmann, Rebecca Looringh-van Beeck

For more information contact Marie Grob, grob@arch.ethz.ch and visit our website: http://u-tt.com/teaching/fall2016elective/

**Language:** English / German

**051-0819-16L**  
**Planning Strategies for Complex Buildings Using the Example of Health Facilities**  
**W**  2 credits  
**2V**  
**T. Guthknecht**

**Abstract**

Independently written scientific paper concerning a subject of planning of complex buildings - such as health facility planning and design - with special focus upon the dynamic changes in this context and the related planning and building reactions to them.

**Objective**

The objective is that the students engage in a debate of a differentiated functional planning as a basis for complex buildings which are to be successful functionally, operationally and in design.

On the basis of a given scope of themes the students carry out research aiming for possible improvements for example in health facility planning. The scope of subjects is announced at the beginning of each semester.

**Content**

Complex buildings such as health care buildings are subject to constant change. In a new hospital building 60% of the diagnostic and treatment areas are subject to building changes within the first 10 years of operation. Architecture has to develop concepts which accommodate this level of dynamics into the building structure in a better way.

In the coming years this need for adaptability is going to be challenges even further by the even more reducing health care resources. The paper should discuss in this context a specific question in detail by analysing problems and developing and discussing potential planning solutions.

**Lecture notes**

Presentations of the lecturer and guests will be made available

**051-0827-16L**  
**Sand: an (in)finite Resource? - Engineering for Development (E4D) Summer School**  
**W**  4 credits  
**9S**  
**D. Hebel**

**Abstract**

The programme revolves around the depleting resource sand and the question of how to develop alternative building materials for future cities. The course is for 30 master and doctoral students from ETH Zurich and other academic institutions (from different disciplines related to the topic), joined by faculty members and external experts from fields of expertise related to the winter school topic.

**Objective**

The E4D summer school 2016 aims to develop an integrated vision to a global challenge of today's construction industry. The programme revolves around the depleting resource sand and the question of how to develop alternative building materials for future cities. Led by different experts from around the world, students will not only learn the theoretic background of this resource but experiment with current and future technologies to transform sand and building waste. In the workshops the acquired knowledge will be tested and applied. The summer school presents three areas that could mobilise sand alternatives for construction and other applications: (i) I. Microbiologically Induced Calcite Precipitation (MICP), (ii) Chemical Crystallization Processes and (iii) 3D printing.
Content

Sand is the most commonly used raw material for the production of goods on our planet. It is found in concrete, glass, computers, detergents and toothpaste. Sand is the megastar of the industrial and digital era - our culture is literally built upon this resource. But sand is not equal to sand: the construction industry requires grain sizes and rough shapes that are only found in river beds, lakes and the oceans. Mining of aquatic sand comes at high environmental and social costs; its growing demand cannot be met sustainably. Sand is mostly comprised of quartz, a mineral form of silicon dioxide. Silicon is one of the most abundant elements in the earth's crust. These properties make it valuable to various industries. Since a few years demand for sand has risen exponentially. Alternatives for sand for construction have yet to be developed.

Sustainability is often referred to as an interaction of social, cultural, economic, and ecological aspects. In the construction industry sustainability has been perceived as the optimisation of existing material and energy uses, yet the fundamental energetic and material character of these base resources has not been questioned. The speed of consumption of these resources increases constantly due to demographic pressure and resulting construction, as seen around the world and in particular in developing and emerging countries. A fundamental understanding of metabolic processes is required to frame the question of material and energetic sustainability. At the same time the definition of resources expands to include previously undervalued materials and waste. Finally, advances in digital technology and science have opened new avenues for alternative materials and processes.

The summer school presents three areas that could mobilise sand alternatives for construction and other applications:

I. Microbiologically Induced Calcite Precipitation (MICP): Also known as bio-cementation it is a process utilised in self-healing concrete and soil stabilisation. The application to sand will produce naturally grown structural sand bricks. This workshop will compare MICP for various sand types, building wastes and bacterial cultures.

II. Chemical Crystallization Processes: Based on material computation experiments pioneered by architect and engineer Frei Otto, this workshop combines form finding properties of sand with structural and thinking and chemical crystallization processes.

III. 3D Printing: 3D printing with sand and building waste, finally, explores the potential of sand as a substrate within a binding agent. In combination with a robotic arm, 3D printing of sand is an in situ digitally controlled construction process. It overcomes the need for traditional form-work and transportation of material, thereby reducing the grey energy.

Prerequisites / notice

Taking place from 4 to 22 July 2016 at the TU Delft in The Netherlands.

Costs: CHF 500, including board and accommodation. All participants are responsible for organising and financing their own domestic or international travel to Delft, The Netherlands.

The Engineering for Development (E4D) Winter School 2016 will invite 30 master and doctoral students from different disciplines related to the topic of the summer school. Applicants will be selected based on their academic record and previous work experiences. Applicants must send a one-page CV and one-page letter of motivation in PDF format stating their interest, to Ms. María Ubiera Aparicio (ubierna@fzu.baug.ethz.ch)

Deadline: 31 March 2016

Notification: 15 April 2016

051-0829-16L

Summer School: Assembling Cities. Studying Urban Matters in Practice

W 2 credits 4U D. Eberle

Objective

The objective of the summer school is to support PhD researchers in their individual research and specific research stages by sharing their work with keynotes and colleagues. Accordingly, participants are expected to develop their skills of articulating and communicating their ideas, examine various STS methods and techniques of approaching cities, and to discuss their research and obstacles in an academic setting. For the three sessions; problematizing, describing and assembling stages of their research to learn about the relevance of STS methodologies and concepts of urban research in general, and for their particular interest and research stage. They are also aimed at researchers not yet familiar with the approach and interested in learning a subset of its concepts (eg. networks/artefacts) and methodologies (e.g. ethnography/digital methods). Throughout the sessions participants will learn to: question the city from a STS perspective (problematising), they will be introduced to the methodologies that tackle these questions (describing), and they will encounter ways of thinking through questions and answers (assembling). Specifically, participants are to write a full paper, design a poster and make a presentation. All deliverables will be evaluated by the keynote speakers, four external reviewers, and the organizers. The poster presentation will take place in front of a full audience, while paper presentations in the workshop group. The organizers are looking for publishing opportunities of outstanding papers (eg. paperNext from the AESOP YA, Contour at the EPFL or Spatum at the IAU5). The website will be updated with the posters and a review of following the event.

Content

The relevance of STS in urban research is explored with three themes: problematising, describing and assembling (cities). Participants will be distributed in thematic groups, and lectures will be held by keynote speakers according to theme. Following the call, participants are required to indicate which theme fits their paper best as they will be shared within the thematic groups. The first day will include a keynote presentation followed by an informal poster session for each thematic group. The poster sessions are a chance for the other two groups to learn about participants’ research and ask questions. The following day two sessions will be held with the support of the respective keynote.

During the first (morning) session the participants will present their papers (max 15 min) within their thematic groups followed by a general 20 min discussion. During this time, key points will be noted and later discussed in the second (afternoon) session in which each group will prepare a plenary discussion and plan for the final day. The final day presentation for the final day. The final day presentation will be given by the respective keynote and moderated by members of the thematic group. Each thematic group will summarise their discussions and findings in a final presentation. The framework for the discussion and presentations will be defined together with the keynotes and could be, for example, a specific question and/or obstacle, a clear toolbox, or excerpts from selected presentations related to each respective theme.

The summer school will open with an excursion to the housing project Hunzikerareal by the housing cooperative Mehr als wohnen in Zurich. This large mixed-use area development is used as an example of how institutions, individuals and artefacts mediate the planning process towards an inclusionary and diverse project.
Cities on the border or an outpost of Western European influence, struggling between globalization, modernization and local traditions, are
H. Klumpner

An alternative, experiential approach to architectural education; a humanistic understanding of architecture's relationship to language; a
Summer School: Learning from Havana
4 credits

The course will function as an inter-disciplinary think-tank exploring the requisites for sustainable urban development of the Old Havana
Port (UNESCO World Heritage site) through the lens of architecture, engineering, and social sciences. The challenge is to work in an
intensive cross-cultural setting and develop solutions in a complex, real-life context with local practitioners and stakeholders.

You will receive full support on-site from the Politecnico University José Antonio Echeverría, La Habana (PUJAE) and ETH tutors from
your discipline. In developing the scenarios you will work side by side with young professionals with a grounded knowledge of the field, and
be joined by a wide variety of local stakeholders.

The program will combine site visits, expert lectures and workshops to allow you to develop the following skills:
The capacity to work to address urban challenges in an inter-disciplinary team;

Conduct your own research within a limited time frame and through quantitative and qualitative analysis;

Apply Scenario Analysis technique to structure and integrate knowledge from various fields;

Cross cultural understanding and skills in an international collaboration;

Mechanisms to collaborate and communicate with practitioners and stakeholders;

Developing integrated and sustainable urban development strategies.

Content

Cities on the border or an outpost of Western European influence, struggling between globalization, modernization and local traditions, are
characterized by great social and spatial disparity. Havana is a characteristic case of such a city, which is currently undergoing rapid
urbanization and experiences a critical moment of transition.

At this very moment, the political and economical situation is changing rapidly, with a contradictory process of economic and social opening
that becomes now more and more visible in the streets of Havana, with new businesses, restaurants and street activities, announcing
further changes in everyday life. How can such fragmented conditions within cities be tackled by integrated and inclusive solutions, rather
than fragmented interventions that exclude the challenged local communities?

Moreover, the lack of resources in cities of the Global South often prevents the gathering of modern, digitalized data, while the unstable
political structures prevent the implementation of durable planning strategies. These cities need a rapid assessment procedure, in order to
identify relevant priorities and potentials. How can we create a comprehensive understanding of the system and propose appropriate
solutions, while using quantitative and qualitative data?

The summer school will build on the current "Atlas Urbano de La Havana - Urban Atlas of Havana" and on the project SeDUT (Seminario
Internacional de Desarrollo Urbano y Transporte), a three-year Swiss-Cuban cooperative research project on the urban development of
Havana and its mobility potentials. The SeDUT project involved many academic, governmental and private stakeholders, such as the
Politecnico University José Antonio Echeverría, the Centro de Estudios Urbanos de La Habana, the Instituto de Planificación Física, the
Dirección Provincial de Planificación Física de la Ciudad de La Habana and the design office of Metron AG. Together they represent an
important expertise and a high degree of accumulated knowledge.

In a team, you will produce alternative urban scenarios for the planned redevelopment of the Old Port of Havana. You will contribute your
expertise and unpack the realities of sustainable development in a tropical climate. How can knowledge from the ETH be combined with
Cuban research and translated to a Caribbean context? Through debate, controversy and collaboration it is expected you produce
scenarios that integrate your different disciplines and question the preconceptions of sustainable urban development.

This immersive summer school will be structured in three interlocking modules:
In the first module you will investigate the Old Port and gain a strong understanding of the social, environmental and built context in
Havana. You will employ analytical mapping to integrate and synthesize different disciplinary knowledge, ranging from quantitative data to
subjective observation.

In the second module, you will develop a series of scenarios for the Old Port, proposing alternatives for its sustainable future. You will build
on the research from the first module, and explore the potential of your ideas with local stakeholders and professionals from your field. You
will document these scenarios using creative and varied representational methods.

In the final module you will pitch your scenarios to decision makers. During this event you will measure their preferences, debate the
associated trade-offs, and provide a series of orientations for those planning the future of Havana.

More information on: http://i-it.com/teaching/havana-summer-school/

Who should apply?
Enthusiastic students currently enrolled in a masters program in ETH Zurich and PUJAE Havana. A balanced group of 15 ETH master
students from the D-ARCH, D-BAUG, D-GESS and D-USYS departments will be selected. They will be joined by 15 Cuban students from
our partner university.

Applicants should have a strong interest in sustainable urban development and transdisciplinary collaborative research. They should be
able to demonstrate their academic strength, motivation, interest and expertise. Knowledge of Spanish is welcome but not obligatory.

Dates in Cuba: 21 August to 1st of September.
Contact: Marie Grob at grob@arch.ethz.ch, enrollment procedure on our webpage.

063-0321-16L

Summer School: Summer Chantier Valparaiso Chile
4 credits

This program serves to guide the project at its origins. During the summer, and in the intervening school year, groups and students and
faculty respond to the existing conditions with tests and interventions that develop the project. This development is also influenced by
poetic acts that take place on the project site that open up or introduce new prerogatives or potentials into the work.

An alternative, experiential approach to architectural education; a humanistic understanding of architecture's relationship to language; a
direct relationship to site where drawing and observation are used as practical tools; a direct contact with materials, fabrication and
assembly that draws on “low-tech”, handson construction methods and their poetic potential; these are the main objectives and principal
achievements of the Building Cultures_Summer Chantier program.

Abstract

The program will function as an inter-disciplinary think-tank exploring the requisites for sustainable urban development of the Old Havana
Port (UNESCO World Heritage site) through the lens of architecture, engineering, and social sciences. The challenge is to work in an
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063-0321-16L

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4 credits

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assembly that draws on “low-tech”, handson construction methods and their poetic potential; these are the main objectives and principal
achievements of the Building Cultures_Summer Chantier program.
Site: La Ciudad Abierta (the Open City)
Founded in 1970, the Open City occupies a 300 hectare parcel of land on the Pacific Ocean, 1 hour north of Valparaiso, Chile and 20 minutes north of Concon. The land comprises diverse ecosystems including wetlands, dunes and temperate forests and is divided in two by a busy two-lane highway. Founded by teachers from the School of Architecture and Design of the Pontifical Catholic University of Valparaiso (e[ad]PUCV) as a place to explore the humanistic potential of architecture - as a poetic space making discipline and as a means to propose new forms of community. The Open City is home to 14 families who live there on a permanent-basis and is also the site of weekly classes and activities for students and faculty from the e[ad]PUCV. The structures nestled in the landscape have been developed and built by students and faculty over the course of the Open City's history.

Project: El Portico de los Huéspedes
El Portico de los Huéspedes is the first permanent structure to be proposed in the Open City in nearly 12 years and was begun through the collaboration between Summer Chantier and the e[ad]PUCV in the summer of 2014. An initial program for the structure was developed by the Open City members and responds to a need within the community for permanent space for both the administrative secretary of the Open City and for guests conducting research. In addition, the program responded to a desire to create a space large enough for the entire e[ad] PUCV community to assemble within the Open City itself. This program is not a set of fixed guidelines but served, and serves, to guide the project at its origins. Similarly, le Portico de los Huéspedes has no fixed plan or finality. During the summer, and in the intervening school year, groups and students and faculty respond to the existing conditions with tests and interventions that develop the project. This development is also influenced by poetic acts that take place on the project site that open up or introduce new prerogatives or potentials into the work.

Project History 2014/15:
Poetic act defining the amplitude of the necessary site;
Definition of the site location, development of principal structure based on a study of Gunnar Asplund's Woodland chapel;
Replacement of wooden pile foundations with concrete foundations;
Poetic Act defining points within the site that became manifested through flexible form-work columns;
Development of secondary structure in wood and brick plazas on northeast and south west corner of site.

Program Outline:
Lausanne Week (late July): The Lausanne week is an intense period of analysis of the existing site conditions. This first encounter with the Open City and le Portico de los Huéspedes is supplemented with lectures that introduce students to some of the ideas defining practice and pedagogy at the Open City: the role of poetry and poiesis, observation and the open-ended project. Site analysis is done through drawing (by hand with tools supplied by the workshop) and model making. Work-days finish with informal critiques where findings are discussed. During the week there will also be an introduction to the working and safety issues related to the chantier and to living near the Open City. Students will work in teams and one of the goals of the week is to already to create a group spirit that will develop throughout the workshop.

Open City (August): The first days of the chantier is meant as a practical introduction to some of the ideas encountered during the Lausanne week. Lectures and events by members of the Open City community introduce students to the pedagogical and poetic potentials into the work.

Applications will be expected until 18th March with interviews conducted in early April and decisions made shortly afterwards.

051-0623-16L Travellers, Ocean Territories - Mapping Maritime Geopolitics, Migration and Global Trade
Abstract
Travellers is a series of five lectures and conversations about ways of perceiving, studying and portraying urban territories. Each of the guest speakers is a traveler - a person who places the direct observation and experience of urban landscapes in the core of their practice. During the autumn of 2016, we will investigate the ocean as a territory.

Objective
The architectural ways of looking, concepts and techniques are unstable at large territorial scales, and yet, urban territories can be seen as crucial contexts for the production of architecture. Seeing an extended urban territory as part of the city - its mirror - can reflect back in the ways we see the city itself, and its architectures.

Once a year in autumn, with students and invited guests, we will consider: How can architects look at, study and design urban territories or the "city's constitutive outside": the periphery, the agglomeration, the countryside and the hinterland? What are the motives (aesthetic, political) architects can have in engaging with these territories? The aim is to discuss concepts and techniques for territorial investigations and projects.

During the autumn of 2016, we will investigate the ocean as a territory through the lens of artists, researchers and architects focusing on mapping maritime geopolitics, migration and global trade.
What is the ocean as a territory? Once imagined as a boundless space, largely untouched by human activity, are oceans still a common horizon bringing together the cities and peoples along their shores? Can the open nature of the sea resist the transformative forces of the carved and conflicted earthly masses it is enclosing? Is the ocean space shaped by the strategic control of resources and trade routes? What is the role of the architects in investigating, describing and visualising the urban dynamic of the ocean space? Can ocean territories be designed?

Taking different perspectives, from history, to activism, geopolitics, and design, travellers who have been crossing the global ocean following refugee migrations, onboard container ships and along ancient maritime routes, contribute elements for an urban portrait of ocean territories.

03.10.2016
On Migration: MANUEL HERZ
architect/researcher

17.10.2016
On Urbanisation of the Sea: NANCY COULING
architect/researcher

31.10.2016
(TBC)

14.11.2016
(TBC)

28.11.2016
On the Island of Lampedusa:
ANA DANA BEROS
architect/researcher
conversation with Dubravka Sekulic

Please visit http://topalovic.arch.ethz.ch/projects/ocean-territories/ for updates!

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<th>Number</th>
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<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>to be announced</td>
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Prerequisites / notice
Not eligible as a Compulsory GESS Elective for students of D-ARCH.

Abstract
The historical analysis the students will acquire instruments for a critical examination of the conditions of the current production of the built environment, in order to develop a sovereign theoretical position on the contemporary architecture.

Objective
The seminar will deal with the conventions of the contemporary architectural practice. The proposed topics should be researched out of a twofold, historical as well as systematic perspective. A detailed description of the syllabus can be found on the homepage of the professorship: http://stalder.gta.arch.ethz.ch/seminarien.php

Content
Prerequisites / notice
Not eligible as a Compulsory GESS Elective for students of D-ARCH.

Abstract
The seminar analyses the conditions of contemporary architectural production. In doing so, the importance and meaning of architectural conventions for the design, construction as well as for the transformation of single buildings is systematically challenged.

Objective
The seminar aims at a critical analysis of both material and ideological conventions of the architectural practice. On the basis of the historical analysis the students will acquire instruments for a critical examination of the conditions of the current production of the built environment, in order to develop a sovereign theoretical position on the contemporary architecture.

Content
The seminar will deal with the conventions of the contemporary architectural practice. The proposed topics should be researched out of a twofold, historical as well as systematic perspective. A detailed description of the syllabus can be found on the homepage of the professorship: http://stalder.gta.arch.ethz.ch/seminarien.php

Abstract
The seminar investigates Chicago's role as model for the American large city in the 20th Century. Particularly, the influence of property speculation and technical improvement - responsible for the nearly unlimited growth of the city (mainly into the hight) - are critically analyzed. At the same time we investigate the architects' handling with new technical possibilities, but also with social problems related to it, as Louis Sullivan did in a exemplary way in «The tall office building artistically considered» in 1896.

Objective
In the last third of the 19th Century Chicago became center of attraction for a whole generation of American architects, William Le Baron Jenney, Louis Sullivan und Frank Lloyd Wright - based in Chicago - formed the image of an American large town. Between 1893 Chicago was the site of the World's Columbian Exposition in honour of America's discovery 400 years ago. Chicago, the city in the middle west, had competed successfully against New York, Cincinnati and Washington D.C to get this once-in-a-hundred-years-event. In historical view this is less than understandable, because not even 25 years before that Chicago hardly counted 220'000 inhabitants. Upon connection to the railway net and the subsequent settlement of meat manufacture industries the city had a cometlike rise which couldn't even be stopped by a conflagration in 1871. In the shade of the technical and industrial progress social circumstances which were critizised severely arose.

In the contrast to the railway net and the subsequent settlement of meat manufacture industries the city had a cometlike rise which couldn't even be stopped by a conflagration in 1871. Upon connection to the railway net and the subsequent settlement of meat manufacture industries the city had a cometlike rise which couldn't even be stopped by a conflagration in 1871.

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We will explore the history of the GTA as well as the historical and theoretical dimensions of the interview as a research and seminar tool. Within our series «Elements of the urban space» we will focus on urban housing. In the parishes Niederdorf, St. Hildegard, Fluntern und Hirslanden, we will look at numerous housing types on the level of the metropolis, the neighborhood, the building, and the urban detail. In doing so, we aim to gather criteria, that are fundamental to an urban living situation.

Objective
The aim of the seminar series is to provide a sound methodological approach in analyzing urban space on the scale of the metropolis, the neighborhood, the building and the urban detail. Through a series of neighborhood walks and excursions to the four major city archives, our students gain a methodological approach to city analysis. In the discourse of the seminar, we will gain fundamental criteria for the design of urban situations.

Lecture notes
Our students will be provided with all material in digital form.

Literature
We will provide our students with a selection of literature and all necessary planning documents in digital form.

Prerequisites / notice
The number of students is limited to 60. After the introduction on 22/09 between 14.45-16.30 we will meet on 29/9 (city walk), 6/10 (discussion of the analysis results), 13/10. (consultation - doodle), 3/11 (excess plan archives), 10/11 and 1/12 (consultation - doodle) and final presentation on 8/12.

Seminar History of Urban Design: Elements of Urban Space
V. Magnago Lampugnani

<table>
<thead>
<tr>
<th>Course Code</th>
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<td>051-0783-16L</td>
<td>Special Questions in History of Art and Architecture: Making of the GTA</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>D. Imhof, B. Seidel</td>
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<td>051-0165-16L</td>
<td>Housing</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>to be announced</td>
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Data: 06.11.2018 12:57 Autumn Semester 2016 Page 121 of 1571
Housing considered in context: architectural, cultural, social, technical and economic conditions and processes influence housing and modes of habitation. To what extent have they changed in the last century? The construction and renovation of domestic space is a cultural process. What forces construct that space, and according to which criteria? What are the constructional and organizational solutions with which they confront the diversity and metamorphosis of contemporary modes of habitation? How can postulates concerning a sustainable development be implemented? Insights culled from housing research and practice, podium discussions with guests and current examples of innovative housing are included.

Literature
als grundlegende Einführung:
Dietmar Eberle u. Marie Glaser (Hrsg.): Wohnen im Wechselspiel zwischen privat und öffentlich, Niggli Verlag 2009

Leseliste: Obligatorische Literatur zum Thema ist unter www.wohnforum.arch.ethz.ch abrufbar

### Thesis Electives

<table>
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<tr>
<th>Number</th>
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<tr>
<td>051-0619-16L</td>
<td>Urban Mutations on the Edge: Commoning</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Angélil</td>
</tr>
<tr>
<td>Abstract</td>
<td>The Urban Mutations on the Edge seminar is a series of public lectures by ETH faculty and invited guests addressing the dynamic global peripheries that we believe are most actively changing our conception of the city.</td>
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<tr>
<td>Objective</td>
<td>Participants should leave the course with an understanding of current urban research issues and an introduction to the political dimension of contemporary architectural production.</td>
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<tr>
<td>Content</td>
<td>The Urban Mutations on the Edge seminar is a series of public lectures by ETH faculty and invited guests addressing the dynamic global peripheries that we believe are most actively changing our conception of the city.</td>
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<tr>
<td>Lecture notes</td>
<td>Texts to accompany and provide context for each lecture are sent weekly by email.</td>
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<tr>
<td>051-0813-16L</td>
<td>Sociology: Urban Quality of Life - Ethnological Field Research in District 5 and in Zurich North</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>C. Schmid, H. Nigg</td>
</tr>
<tr>
<td>Abstract</td>
<td>In this ethnographic field research we examine the question, how people are perceiving and creating their environment, and how an urban quality of life is forming. We investigate four neighborhoods in the Zurich Region: upper District 5, Zurich West, Seebach and Glattpark.</td>
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<tr>
<td>Objective</td>
<td>This elective course highlights the sociological perspective on architectural practice and provides an introduction to sociological research. It focuses on two main procedures: on the one hand, a systematic reading and discussion of theoretical texts, and on the other, empirical case studies of social aspects of the production of the built environment. In this course, a wide set of qualitative research methods is used (including various forms of interview, participant observation, image and text analyses). This approach enables students to gain their own experience by dealing with the various participants and constellations in the social field of architecture and building construction, and to familiarize themselves with the approaches and perceptions of various different participants.</td>
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<tr>
<td>Content</td>
<td>An introduction into ethnographic field research. Urban ethnography concentrates on the urban space, on urban actors, on the cityscape and compares cities of different continents and cultures with each other. Urban ethnology investigates symbols and practices representing and participating in the normal course of city life. Urban ethnology understands urban space not only as built environment, but also as a lived cultural and social context. With ethnographic field research the perception of actors in local milieus is investigated. How do they see and experience urban contexts? How do they move in the city area? How do they recognize houses, roads and places? How do they hear the city? The perception of local milieus, their obstinacy, creativity and their special way of life is considered significant for better understanding the city as central point of current social development. For ethnographic surveys of the built environment architects nowadays use a number of methods and techniques: participating in observation, interviews, photo and video site inspections in urban rooms, mindmapping etc.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Language: German or English</td>
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Dr. Heinz Nigg ist Ethnologe und Kulturschaffender

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#### Architecture  (Thesis Elective)

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>051-0803-16L</td>
<td>Seminar Architectural Criticism</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>L. Stalder</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the framework of three elective courses, students need to prepare elective works (seminar works). The aim of these papers is to foster an independent engagement with the subjects of the seminar. A scientific familiarization with the respective themes is required. The extent of such a paper ranges from 20 to 30 pages.</td>
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<tr>
<td>Objective</td>
<td>The contents of these elective studies are expected to link to the subject matter of the course architectural criticism. Interested students are kindly asked to contact us in order to discuss possible projects.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Zum methodischen Verlassen einer Wahlachtarbeiten siehe das Merkblatt unter: <a href="http://www.wohnforum.arch.ethz.ch/lehre/wiss_wahlacht-wohnen.html">http://www.wohnforum.arch.ethz.ch/lehre/wiss_wahlacht-wohnen.html</a></td>
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#### History, Criticism and Theory of Architecture: City and Architecture (Thesis Elective)

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<tbody>
<tr>
<td>Abstract</td>
<td>The seminar aims to analyse housing in context. Group discussions, working with literature and data material as well as the elective thesis focus on architectural, cultural, social and economic conditions and processes that influence housing and the modes of habitation.</td>
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<tr>
<td>Objective</td>
<td>The students will provide a differentiated analysis on the subject housing within its social, cultural and economic context. By working scientifically on a individually chosen subject in their elective thesis, they reflect and analyse on the major problems and determine the players and practices, as well as they depict well structured outcomes.</td>
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<tr>
<td>Content</td>
<td>This knowledge gained from the lecture series of technical installations will be applied in this elective work. Focusing on specific questions, this knowledge will be deepened. Each topic will be individually discussed with each student. Based on the design of studios or other projects, a building will be examined with the goal of emissions-free building operation.</td>
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<td>Language: German or English</td>
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Having passed the lecture series of Energy and Climate Systems I & II or Technical Installations I & II respectively is required for attending the Integrated Discipline.

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#### Architecture and Building Systems (Thesis Elective)

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<tr>
<th>Number</th>
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<tr>
<td>051-0115-16L</td>
<td>Architecture and Building Systems</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>A. Schlüter</td>
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<tr>
<td>Abstract</td>
<td>The knowledge gained from the lecture series of technical installations will be applied in this elective course work. Focusing on specific questions, this knowledge will be deepened. Each topic will be individually discussed with each student. Based on the design of studios or other projects, a building will be examined with the goal of emissions-free building operation.</td>
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<tr>
<td>Objective</td>
<td>The objectives are to understand the challenges that arise with these aspects of sustainability, to dimension the resulting technical systems and components, and to implement this in architecture.</td>
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<tr>
<td>Content</td>
<td>The knowledge gained from the lecture series of technical installations will be applied in this elective course work. Focusing on specific questions, this knowledge will be deepened. Each topic will be individually discussed with each student. Based on the design of studios or other projects, a building will be examined with the goal of emissions-free building operation.</td>
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#### Housing (Elective Thesis)

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<td>G. Precht</td>
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<tr>
<td>Abstract</td>
<td>The seminar aims to analyse housing in context. Group discussions, working with literature and data material as well as the elective thesis focus on architectural, cultural, social and economic conditions and processes that influence housing and the modes of habitation.</td>
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<td>Objective</td>
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<tr>
<td>Content</td>
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<tr>
<td>Literature</td>
<td>Siehe LITERATURLISTE unter: <a href="http://www.wohnforum.arch.ethz.ch/lehre/wiss_wahlacht-wohnen.html">http://www.wohnforum.arch.ethz.ch/lehre/wiss_wahlacht-wohnen.html</a></td>
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#### Seminar Architectural Criticism (Thesis Elective)

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<td>051-0169-16L</td>
<td>Seminar Architectural Criticism</td>
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<td>11A</td>
<td>L. Stalder</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the framework of three elective courses, students need to prepare elective works (seminar works). The aim of these papers is to foster an independent engagement with the subjects of the seminar. A scientific familiarization with the respective themes is required. The extent of such a paper ranges from 20 to 30 pages.</td>
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<tr>
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<td>The contents of these elective studies are expected to link to the subject matter of the course architectural criticism. Interested students are kindly asked to contact us in order to discuss possible projects.</td>
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### Prerequisites / notice

Zum methodischen Verlassen einer Wahlachtarbeiten siehe das Merkblatt unter: http://www.wohnforum.arch.ethz.ch/lehre/wiss_wahlacht-wohnen.html

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<td>063-0173-16L</td>
<td>Spatial Concepts in Film and Architecture (Thesis Elective)</td>
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<td>M. E. Agotai Schmid, P. Bächinger Zwicky</td>
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<tr>
<td>063-0187-16L</td>
<td>Procedures in Design - Techniques of Construction (Thesis Elective)</td>
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<td>063-0193-16L</td>
<td>Performance and Intervention (Thesis Elective)</td>
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<td>063-0219-16L</td>
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<tr>
<td>063-0227-16L</td>
<td>Architectural Drawing - Image Lab (Thesis Elective)</td>
<td>6</td>
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<td>R. Fässer</td>
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**Abstract**

Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.

**Objective**

The aim of these papers is to foster an independent engagement with the subjects of the seminar. A scientific familiarization with the respective themes is required. The extent of such a paper ranges from 20 to 30 pages.

**Content**

The contents of these elective studies are expected to link to the subject matter of the attended course.

**Prerequisites / notice**

Application for the coursework with the lecuturer also via e-mail: San Keller <stefan.keller@arch.ethz.ch>
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course. The contents of these elective studies are expected to link to the subject matter of the attended course. Consultation for the individual elective thesis will be available during semester as well as during the free period. The oral examination at the end of the semester break is based on the written thesis, handled in before the the examination (watch the deadline in summer/winter). Appointments for consultation with the junior faculty by arrangement.

Abstract
An elective master thesis in architectural theory is a written student assignment of an architectural problem or question, which is to be elaborated into a scientific paper in consultation with the advisors of the chair. The examination of a specific problem asks for a conscious and critical reflection of interdisciplinary approaches and methods.

Objective
Within the framework of an elective master thesis the student can enhance the acquired knowledge in architectural theory in written form. The objective of this thesis is the master thesis of scientific methods, the derivation, development and verbalization of conclusions and the contextualization within a theoretical setting. In a broader sense it serves the training of verbal skills, the development of a critical verbal, cognitive and imaginary access to problems in the realm of architecture and its neighboring disciplines in the humanities.

Content
The contents of these elective studies are expected to link to the subject matter of the attended course. Consultation for the individual elective thesis will be available during semester as well as during the free period. The oral examination at the end of the semester break is based on the written thesis, handled in before the the examination (watch the deadline in summer/winter). Appointments for consultation with the junior faculty by arrangement.

063-0317-16L History of Art and Architecture (Thesis Elective) ■ W 6 credits 11A P. Ursprung
Abstract
Independent and scientific thesis on a monographic or thematic topic within the scope of the history of art and architecture.

Objective
The objective is to write an independent thesis on a monographic or thematic topic within the scope of the history of art and architecture. The focus is to thus exemplify a comprehensive view of the approach and methods towards the modern history of art.

Content
The objective of the elective subject is, in coordination with the advisors, to work autonomously on a subject from the history of architecture. Beside own ideas also positions of research should be considered; we set value on a correct scientific form as well as a clear language. The work should cover 36'000 signs as well as image material if needed. At the beginning and before delivery of the work an elaborate discussion will take place.

Abstract
Essay on a Subject from the Field of Architectural History

Objective
Independent preparation of a scholarly essay on a topic from the field of architectural history.

Content
The aim of the elective course paper is to discuss a topic freely selected from the field of architectural history, in agreement with the assistant lecturer(s). In addition to original ideas, positions taken in the history of research on the subject should also be discussed. It is important to use the correct scholarly format and clear language. The paper should be approximately 40'000 characters in length and should also include as much pictorial material as needed.

http://www.toennesmann.arch.ethz.ch/papers
Prerequisites / notice
Please contact the assistants before the inscription.

063-0355-16L Preservation of Cultural Heritage (Thesis Elective) ■ W 6 credits 11A S. Holzer
Abstract
The Elective Subject Degree Tests are meant to enable a deeper level of individual engagement with the contents of the elective subjects. Topics of electives can be elaborated into elective degree tests.

Objective
The general aim of this intensification is teaching competency in analysis and interpretation in the following areas: knowledge of artifacts, dynamics of systems, historical contexts, history of knowledge and theory as well as an approach to scholarly work.

Content
Contents depend on the specific curriculum of each semester and will be determined in consultation with the faculty advisor. Independent study is possible, however, only after consultation.

063-0367-16L History of Urban Design (Thesis Elective) ■ W 6 credits 11A V. Magnago Lampugnani
Abstract
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.

Objective
The aim of this seminar work is to learn how to write a small thesis on a case study. This work should include a creative text, but also to obey certain rules, which turn a regular text into a scientific one.

Content
The contents of these elective studies are expected to link to the subject matter of the attended course. Einer Anmeldung zum Wahlfach muss ein Gespräch mit einem der Assistenten des Lehrstuhls vorangehen. Es ist daher vor einer Anmeldung ratsam Kontakt zu einem der Betreuungsassistenten aufzunehmen.

Abstract
Feminine theory of urban design (18th-21st century). The task of this seminar is working with texts about the city written by women. The texts will be analyzed, compared and examined employing different scientific methods.

Objective
The main aim of this seminar is learning the scientific handling of theoretical texts on the city. These texts range from pamphlets, to commentaries and literary products.

Content
The contents of these elective studies are expected to link to the subject matter of the attended course.

Abstract
The efforts for entanglements of architectonic and constructive concepts had resulted in wide discussions and in unique buildings during different time periods (i.e. ferroconcrete in the nineteen-thirtees and nineteen-fifties), furthermore to architectonic and technical enrichments.

Objective
Getting to know important critical figures between architecture and engineering as well as their attitudes and concepts and the most distinguished buildings.

Content
Seminar to the studies and for discussion of important texts and buildings of the most famous construction engineers and architects by listening to reviews, presentations and models, input lectures and guest speeches, films and joint surveys.

063-0515-16L Building Physics (Thesis Elective) ■ W 6 credits 11A J. Carmeliet
Prerequisites for Urban Physics: successful termination of "Building Physics IV: Urban Physics". For Building Physics in general: Knowledge in the relevant field.

Abstract
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.

Objective
The aim of the elective work is to gain comprehensive insight in specific issues related to urban physics and low-energy buildings. These issues may concern: wind & thermal comfort in the built environment, heat islands, cross-ventilation, driving rain, pollution dispersion, new technologies for low-energy buildings, design of building systems, optimal control. The work may include computational modelling and prototype testing in laboratory.

Content
The contents of these elective studies are expected to link to the subject matter of the attended course.
<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>063-0619-16L</td>
<td>Urban Mutations on the Edge (Thesis Elective)</td>
<td>W 6</td>
<td>M. Angéll</td>
<td>This Thesis Elective is an introduction to urban research, how to conduct it, and why it is a useful undertaking. The basis of the course is the Urban Mutations on the Edge lecture series. Additional seminar and individual meetings are held on select Thursdays throughout the semester.</td>
</tr>
<tr>
<td>063-0621-16L</td>
<td>Architecture and Digital Fabrication (Thesis Elective)</td>
<td>W 6</td>
<td>F. Gramazio, M. Kohler</td>
<td>Advance in technology revolutionizes design and fabrication processes within architecture. Digital fabrication allows immediate production from design data. The architect as author of these data takes a key role in this development. This course focuses on strategies for architectural production by means of algorithmic design tools and computer controlled fabrication methods.</td>
</tr>
<tr>
<td>063-0625-16L</td>
<td>Serendipity (Thesis Elective)</td>
<td>W 6</td>
<td>C. Girot</td>
<td>The subject of the elective thesis is tied to the correspondent elective subject. The elective gives students the opportunity to expand their knowledge in the area of landscape architecture.</td>
</tr>
<tr>
<td>063-0627-16L</td>
<td>Topology (Thesis Elective)</td>
<td>W 6</td>
<td>C. Girot</td>
<td>Self dependent thesis under the supervision of the tutor, alternately held by the TheoryLab in the spring semester and the DesignLab in the autumn semester. It serves to continue the discussion with the themes of the elective course. The subject of the elective thesis is tied to the correspondent elective subject (precondition: enrolment to the course).</td>
</tr>
<tr>
<td>063-0629-16L</td>
<td>Pairi-Daeza: Water (Elective Thesis)</td>
<td>W 6</td>
<td>G. Vogt</td>
<td>The term &quot;pairi-daeza&quot;, Persian for &quot;a wall surrounding a garden&quot;, is the point of origin for an elective series addressing basic elements of landscape architecture. This semester, students will deal with the topic 'Threshold', developing a design for a metropolitan park in Lyon.</td>
</tr>
<tr>
<td>063-0667-16L</td>
<td>Case Studies in Urban Design (Thesis Elective)</td>
<td>W 6</td>
<td>K. Christiaanse</td>
<td>Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.</td>
</tr>
<tr>
<td>063-0723-16L</td>
<td>Information Architecture (Thesis Elective)</td>
<td>W 6</td>
<td>G. Schmitt</td>
<td>The students can explore an ongoing subject from teaching or research of the chair &quot;Information Architecture&quot; in detail. In consultation with the chair individual topics are possible, too.</td>
</tr>
</tbody>
</table>
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.

**CAAD Theory (Thesis Elective)**
- **W** 6 credits 11A
- **L. Hovestadt**
  - **Abstract** Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.
  - **Objective** Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.
  - **Content** AUTUMN SEMESTER: In this course an introduction to programming is given with the intention to understand programming as formulation of an intention which eventually yields architectural results. In addition, fundamental techniques are explained and as well as elements of graphics programming introduced. On the other hand, methods are also taught which permit ideas to be converted into viable programs. Although in the course the programming language C++ and a special programming environment is used, a large part of the learning can be used for other programming languages.
  - **Lecture notes**
  - **Literature**
  - **www.caad.arch.ethz.ch**

- **W** 6 credits 11A to be announced
  - **Abstract** The Elective Subject Degree Tests are meant to enable a deeper level of individual engagement with the contents of the elective subjects. Topics of electives can be elaborated into elective degree tests.
  - **Objective** The general aim of this intensification is teaching competency in analysis and interpretation in the following areas: knowledge of artifacts, dynamics of systems, historical contexts, history of knowledge and theory as well as an approach to scholarly work.
  - **Content** Contents depend on the specific curriculum of each semester and will be determined in consultation with the faculty advisor.
  - **Lecture notes** Script only available in german.
  - **Literature**
  - **www.caad.arch.ethz.ch**

**Building Process: Economy (Thesis Elective)**
- **W** 6 credits 11A
- **H. Reichel**
  - **Abstract** Elective works serve the independent way of dealing with the contents of the according elective course.
  - **Objective** To grasp the coherences of costs, income and income return. In-depth studies of the interaction of the market, building costs, finance and location.
  - **Content** Elective works serve the independent way of dealing with the contents of the according elective course.
  - **Lecture notes** Script only available in german.
  - **Literature**
  - **www.bauoek-modell.ethz.ch**

**Sociology (Thesis Elective)**
- **W** 6 credits 11A
- **C. Schmid**
  - **Abstract** Individual thesis with connection to a Master course in Sociology III
  - **Objective** Thesis Electives are reports oriented on the standards of social sciences. Students learn to write a scientific report which follows the state of the art in respect of content, methods, format, internal coherence and scientific validity.
  - **Content** The contents of these elective studies are expected to link to the subject matter of the attended course.

**ACTION! Empowering the Real City (Thesis Elective)**
- **W** 6 credits 11A
- **A. Brillembourg, H. Klumpner**
  - **Abstract** In relation to the elective course "ACTION!" students will have the possibility to extend their research into the behaviours and components that make up the urban realm. A special focus on the processes and mechanisms of (in)formal urban forms and systems will characterise the research. Specific research goals tailored to individual interests will be discussed before proceeding.
  - **Objective** The course will help frame an understanding of the forces shaping (in)formal settlements and the critical behaviours, requirements and practices of its inhabitants. It will also encourage the development of an analytical and critical position on the potential role of the architect to mediate a design process within broader socio-economic, political and ecologic systems.
### 063-0819-16L  Planning Strategies for Complex Buildings - Example: Health Care Buildings (Thesis Elective)

**Lecturers**
T. Guthknecht

**Abstract**
Independently written scientific paper concerning a subject in the area of health facility planning and design with special focus upon the dynamic changes in health care services and the according planning and building reactions to them.

**Objective**
The objective is that the students engage in a debate of a differentialized functional planning as a basis for health care buildings which are to be successful medically, operationally and in design.

**Content**
On the basis of a given scope of themes the students carry out research aiming for possible improvements in health facility planning. The scope of subjects is announced at the beginning of each semester.

In the coming years this need for adaptability is going to be challenges even further by the even more reducing health care resources. The paper should discuss in this context a specific question in detail by analysing problems and developing and discussing potential planning solutions.

### 063-0823-16L  Material-Lab (Thesis Elective)

**Lecturers**
A. Spiro

**Abstract**
The elective works serve an in depth case study through the construction of a 1:1 mock-up.

**Objective**
The students will be enabled to discuss narrowly formulated factual questions in small groups and in direct contact with the professors.

**Content**
The contents of these elective studies are expected to link to the subject matter of the attended course.

### 063-0855-16L  Master Class Construction (Thesis Elective)

**Lecturers**
C. Vogt

**Abstract**
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.

**Objective**
The aim of the Thesis Elective is a independent engagement with the subjects of the related Elective Course.

**Content**
The contents of the elective studies are expected to link to the subject matter of the attended course.

### 063-0763-16L  New Focal Points of Construction (Thesis Elective)

**Lecturers**
D. Mettler, D. Studer

**Abstract**
This self-dependent elective thesis refers to the course "New focal points of construction" demands a rethinking of the learning matter. Hence, a consequent argumentation with regard to the base, the wall, the chamber, the roof etc. follow.

**Objective**
Target of this self-dependent thesis is to rethink the constructive points base, wall, chamber, roof etc. on the basis of the newly acquired skills. A structurally engineered, well-founded hypothesis is formulated, thus serving as a initial position for the conception of future constructions.

**Content**
In the elective thesis "New focal points of constructions" constructive points as base, wall, chamber, roof etc. are rethought reflecting the latest learning matters. A structurally engineered, well-founded hypothesis is formulated, thus serving as a initial position for the conception of future constructions.

### 063-0827-16L  Sand: an (in)finite Resource? - Engineering for Development (E4D) Summer School (Thesis Elective)

**Lecturers**
D. Hebel

**Abstract**
The seminar week is obligatory for students of all semesters. There are many and varied study contents.

**Objective**
The students will be enabled to discuss narrowly formulated factual questions in small groups and in direct contact with the professors.

### Seminar Weeks

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0911-16L</td>
<td>Seminar Week Autumn Semester 2016</td>
<td>W</td>
<td>2</td>
<td>3A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

**Abstract**
The seminar week is obligatory for students of all semesters. There are many and varied study contents.

**Objective**
The students will be enabled to discuss narrowly formulated factual questions in small groups and in direct contact with the professors.

### GESS Science in Perspective

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-1065-00L</td>
<td>Design Thinking: Human-Centred Solutions to Real World Challenges</td>
<td>W</td>
<td>5</td>
<td>5G</td>
<td>A. Cabello Llamas, F. Rittiner, S. Brusoni, C. Hölscher, M. Meboldt</td>
</tr>
</tbody>
</table>

**Abstract**
Due to didactic reasons, the number of participants is limited to 30.

All interested students are invited to apply for this course by sending a one-page motivation letter until 14.9.16 to Florian Rittiner (frittiner@ethz.ch).

Additionally please enroll via mystudies. Places will be assigned after the first lecture on the basis of your motivation letter and commitment for the class.

**Objective**
The goal of this course is to engage students in a multidisciplinary cooperation to tackle real world problems. Following a design thinking approach, students will work in teams to solve a set of design challenges that are organized as a one-week, a three-week, and a final six-week project in collaboration with an external project partner.

Information and application: www.sparklabs.ch/ethz
Content

The purpose of this course is to equip the students with methods and tools to tackle a broad range of problems. Following a Design Thinking approach, the students will learn how to observe and interact with key stakeholders in order to develop an in-depth understanding of what is truly important and emotionally meaningful to the people at the center of a problem. Based on these insights, the students ideate on possible solutions and immediately validated them through quick iterations of prototyping and testing using different tools and materials. The students will work in multidisciplinary teams on a set of challenges that are organized as a one-week, a three-week, and a final six-week project with an external project partner. In this course, the students will learn about the different Design Thinking methods and tools that are needed to generate deep insights, to engage in collaborative ideation, rapid prototyping and iterative testing.

Design Thinking is a deeply human process that taps into the creative abilities we all have, but that get often overlooked by more conventional problem solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as functional, and to express ourselves through means beyond words or symbols. Design Thinking provides an integrated way by incorporating tools, processes and techniques from design, engineering, the humanities and social sciences to identify, define and address diverse challenges. This integration leads to a highly productive collaboration between different disciplines.

For more information and the application visit: http://sparklabs.ch/ethz

Prerequisites / notice

Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0141-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>33 credits</td>
<td>40D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract

The Master-Thesis contains a written proposal due to a given master-programme within the work-field of an architect.

Objective

The Master-Thesis has to be an individual work by the students and be proof of the ability to independent design work.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-1100-AAL</td>
<td>Architectural Design V-IX</td>
<td>E-</td>
<td>13 credits</td>
<td>16U</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php)

Abstract

For Master students with additional obligations only! - Out of the offered courses "Architectural Design V-IX" the student is required to achieve 13 ECTS. There are 2 attempts only.

Objective

Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design methodology and attitude.

Content

For Master students with additional obligations only! - Out of the offered courses "Architectural Design V-IX" the student is required to achieve 13 ECTS. There are 2 attempts only.

Architecture Master - Key for Type

| O    | Compulsory          | E-   | Recommended, not eligible for credits |
| W+   | Eligible for credits and recommended | Z    | Courses outside the curriculum |
| W    | Eligible for credits | Dr   | Suitable for doctorate |

Key for Hours

| V    | lecture          | P    | practical/laboratory course |
| G    | lecture with exercise | A    | independent project |
| U    | exercise         | D    | diploma thesis |
| S    | seminar          | R    | revision course / private study |
| K    | colloquium       |      |                            |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Atmospheric and Climate Science Master

Modules

► Weather Systems and Atmospheric Dynamics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
</tbody>
</table>

Abstract
Dynamic, synoptic Meteorology

Objective
Understanding the dynamics of large-scale atmospheric flow

Content
Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Language notes
Dynamics of large-scale atmospheric flow

Literature
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Prerequisites / notice
Physics I, II, Environmental Fluid Dynamics

651-4053-05L | Boundary Layer Meteorology | W    | 4 credits | 3G        | M. Rotach, P. Calanca

Abstract
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

Objective
Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts.

Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

Content
- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

Language notes
available (i.e. in English)

Literature

Prerequisites / notice
Umwelt-Fluidynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

► Climate Processes and Feedbacks

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1235-00L</td>
<td>Cloud Microphysics</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>U. Lohmann, Z. A. Kanji</td>
</tr>
</tbody>
</table>

Number of participants limited to 16.

Abstract
Clouds are a fascinating atmospheric phenomenon central to the hydrological cycle and the Earth’s climate. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes.

Objective
The learning objective of this course is that students understand the formation of clouds and precipitation and can apply learned principles to interpret atmospheric observations of clouds and precipitation.

Content
see: http://www.ias.ethz.ch/edu/courses/master/modules/cloud-microphysics.html

Language notes
This course will be designed as a reading course in 1-2 small groups of 8 students maximum. It will be based on the textbook below. The students are expected to read chapters of this textbook prior to the class so that open issues, fascinating and/or difficult aspects can be discussed in depth.

Literature

Prerequisites / notice
Target group: Master students in Atmosphere and Climate

701-1251-00L | Land-Climate Dynamics | W    | 3 credits | 2G        | S. I. Seneviratne, E. L. Davin

Abstract
The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

Objective
The students can understand the role of land processes and associated feedbacks for the climate system.

Language notes
Powerpoint slides will be made available

Prerequisites / notice
Prerequisites: Introductory lectures in atmospheric and climate science


► Atmospheric Composition and Cycles

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0572-00L</td>
<td>Aerosols I: Physical and Chemical Principles</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>M. Gysel, U. Baltensperger, H. Burtscher</td>
</tr>
</tbody>
</table>

Abstract
Aerosols I deals with basic physical and chemical properties of aerosol particles. The importance of aerosols in the atmosphere and in other fields is discussed.

Objective
Knowledge of basic physical and chemical properties of aerosol particles and their importance in the atmosphere and in other fields is discussed.

Content
physical and chemical properties of aerosols, aerosol dynamics (diffusion, coagulation...), optical properties (light scattering, -absorption, -extinction), aerosol production, physical and chemical characterization.
This course will introduce some of the main quantitative methods available for the quantitative treatment of geochemical data, as well as the development of a basic knowledge and understanding of the main tools available for the quantitative analysis of geochemical data. Thermodynamical and kinetic basics: bi- and termmolecular reactions, photo-dissociation. Chemical family concept. Chapman chemistry.

The lecture provides in the first part an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and their imp-act on air quality. The second part covers different strategies and techniques for emission reduction. The basic knowledge is deepened by the discussion of specific air pollution problems, scrubbers) with their different mechanisms (field forces, impaction and diffusion processes) and the modelling of these mechanisms. Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biologic conversions).

Objective
The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost. The students know the different techniques of air pollution control and their scientific backgrounds. They are able to incorporate goals concerning the air quality into their engineering work.

Content
Part 1 Emission, Immission, Transmission
- Fluxes of pollutants and their environmental impact
- Physical and chemical processes leading to emission of pollutants
- Mass and energy of processes
- Emission measurement techniques and concepts
- Quantification of emissions from individual and aggregated sources
- Extent and development of the emissions (Switzerland and global)
- Propagation and transport of pollutants (transmission)
- Meteorological parameters influencing air pollution dispersion
- Deterministic and stochastic models describing the air pollution dispersion
- Dispersion models (Gaussian model, box model, receptor model)
- Measurement concepts for ambient air (immission level)
- Extent and development of ambient air mixing ratios
- Goal and instrument of air pollution control

Part 2 Air Pollution Control Technologies
- The reduction of the formation of pollutants is done by modifying the processes (pro-cess-integrated measures) and by different engineering operations for the cleaning of waste gas (downstream pollution control). It will be demonstrated, that the variety of these procedures can be traced back on the application of a few basic principles of physical chemistry.
- Procedures for the removal of particles (inertial separator, filtration) and the removal of gases (absorption, adsorption) and the removal of gases (absorption, adsorption) and the removal of gases (absorption, adsorption) and the removal of gases (absorption, adsorption) and the removal of gases (absorption, adsorption).
- Discussion of the technical possibilities to solve the actual air pollution problems.

Lecture notes
- Brigitte Buchmann, Air pollution control, Part I
- Peter Hofer, Air pollution control, Part II
- Lecture slides and exercises

Prerequisites / notice
- College lectures on basic physics, chemistry and mathematics

701-1233-00L Stratospheric Chemistry

Abstract

Objective
The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect.

Content
Short presentation of thermodynamical and kinetic basics of chemical reactions: bi- and terthermo molecular reactions, photo-dissociation. Introduction to the chemical family concept: active species, their source gases and reservoir gases. Detailed treatment of the pure oxygen family (odd oxygen) according to the Chapman chemistry. Radical reactions of the oxygen species with nitric oxide, active halogens (chlorine and bromine) and odd hydrogen. Ozone depletion cycles. Methane depletion and ozone production in the lower stratosphere (photo-smog reactions). Heterogeneous chemistry on the background aerosol and its significance for heavy air traffic. Chemistry and dynamics of the ozone hole: Formation of polar stratospheric clouds and chloride activation.

Lecture notes
Documents are provided in the contact hours.

Prerequisites / notice
Prerequisites: Basics in physical chemistry are required and an overview equivalent to the bachelor course in atmospheric chemistry (lecture 701-0471-01) is expected.

701-1233-00 V starts in the first week of the semester. The exercises 701-1233-00 U will start only in the 2nd week of the semester.

Climate History and Paleoeclimatology

Number
651-4049-00L Conceptual and Quantitative Methods in Geochemistry

Abstract
For this course the successful completion of the BSc-course "Geochemistry" (651-3400-00L) is a condition.

Objective
Development of a basic knowledge and understanding of the main tools available for the quantitative analysis of geochemical data.
The following approaches will be discussed in detail: major and trace element modelling of magmas, with application to igneous systems; methods and statistics for calculation of isochrons and model ages; reservoir dynamics and one-dimensional modelling of ocean chemistry; modelling speciation in aqueous (hydrothermal, fresh water sea water) fluids.

We will discuss how these methods are applied in a range of Earth Science fields, from cosmochemistry, through mantle and crustal geochemistry, volcanology and igneous petrology, to chemical oceanography.

A special emphasis will be put on dealing with geochemical problems through modeling. Where relevant, software packages will be introduced and applied to real geochemical data.

Lecture notes
Slides of lectures will be available.

Prerequisites / notice
Pre-requisite: Geochemistry (651-3400-00L), Isotope Geochemistry and Geochronology (651-3501-00L).

651-4057-00L Climate History and Palaeoclimatology W 3 credits 2G S. Bernasconi, B. Ausin Gonzalez, A. Fernandez Bremer, A. Gilli

Abstract
The course "Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in palaeoclimatic research.

Objective
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics- through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary palaeoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content
Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.

Geological time, stratigraphy, geological archives, climate archives, palaeoclimate proxies

Climate through geological time: “lessons from the past”

Cretaceous greenhouse climate

The Late Paleocene Thermal Maximum (PETM)

Cenozoic Cooling

Onset and Intensification of Southern Hemisphere Glaciation

Onset and Intensification of Northern Hemisphere Glaciation

Pliocene warmth

Glacial and Interglacials

Millennial-scale climate variability during glaciations

The last deglaciation(s)

The Younger Dryas

Holocene climate - climate and societies

651-4043-00L Sedimentology II: Biological and Chemical Processes in Lacustrine and Marine Systems W 3 credits 2G V. Picotti, A. Gilli

Prerequisite: Successful completion of the MSc-course "Sedimentology I" (651-4041-00L).

Abstract
The course will focus on biological and chemical aspects of sedimentation in marine environments. Marine sedimentation will be traced from coast to deep-sea. The use of stable isotopes palaeoceanography will be discussed. Neritic, hemipelagic and pelagic sediments will be used as proxies for environmental change during times of major perturbations of climate and oceanography.

Objective
-You will understand chemistry and biology of the marine carbonate system
-You will be able to relate carbonate mineralogy with facies and environmental conditions
-You will be familiar with cool-water and warm-water carbonates
-You will see carbonate and organic-carbon rich sediments as part of the global carbon cycle
-You will be able to recognize links between climate and marine carbonate systems (e.g. acidification of oceans and reef growth)
-You will be able to use geological archives as source of information on global change
-You will have an overview of marine sedimentation through time

Content
-carbonates,: chemistry, mineralogy, biology
-carbonate sedimentation from the shelf to the deep sea
-carbonate facies
-cool-water and warm-water carbonates
-organic-carbon and black shales
-C-cycle, carbonates, Corg : CO2 sources and sink
-Carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr
-marine sediments through geological time
-carbonates and evaporites
-lacustrine carbonates
-economic aspects of limestone

Lecture notes
no script. scientific articles will be distributed during the course

Literature
We will read and critically discuss scientific articles relevant for "biological and chemical processes in marine and lacustrine systems"

Prequisites / notice
The grading of students is based on in-class exercises and end-semester examination.

Hydrology and Water Cycle

Number Title Type ECTS Hours Lecturers
701-1251-00L Land-Climate Dynamics W 3 credits 2G S. I. Seneviratne, E. L. Davin

Abstract
The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

Data: 06.11.2018 12:57
Autumn Semester 2016
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

**Prerequisites / notice**

**Literature**
- R-packages with software and example datasets for exercise sessions
- exercise sets and solutions
- documentation and supporting material include:
  - documented view graphs used during the lecture
  - R-packages with software and example datasets for exercise sessions

**Lecture notes**
- Concepts for non-ideal boundary layer conditions
- Spectral characteristics
- Statistical trsetment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Introduction
- Turbulence
- Introduktion
- Statistical trsetment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Concepts for non-ideal boundary layer conditions
- Spectral characteristics

**Language**
- English

**ECTS**
- 3

**Credit**
- 4

**Lectures**
- M. Rotach, P. Calanca

### Electives

**Weather Systems and Atmospheric Dynamics**

Courses are only offered in FS.

**Climate Processes and Feedbacks**

Two additional courses are offered in HS by University of Berne.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
</tbody>
</table>

The students are free to choose individually from the entire course offer of ETH Zürich and the universities of Zürich and Bern.
Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes
Dynamics of large-scale atmospheric flow

Literature
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Prerequisites / notice
Physics I, II, Environmental Fluid Dynamics

651-4057-00L Climate History and Palaeoclimatology

Abstract
The course "Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in paleoclimate research.

Objective
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary paleoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content
Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.

Geological time, stratigraphy, geological archives, climate archives, paleoclimate proxies

Climate through geological time: "lessons from the past"

Cretaceous greenhouse climate

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Pliocene warmth

Glacial and Interglacials

Millennial-scale climate variability during glaciations

The last deglaciation(s)

The Younger Dryas

Holocene climate - climate and societies

Atmospheric Composition and Cycles

Number Title Type ECTS Hours Lecturers
701-1235-00L Cloud Microphysics W 4 credits 2V+1U U. Lohmann, Z. A. Kanji

Abstract
Clouds are a fascinating atmospheric phenomenon central to the hydrological cycle and the Earth’s climate. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes.

Objective
The learning objective of this course is that students understand the formation of clouds and precipitation and can apply learned principles to interpret atmospheric observations of clouds and precipitation.

Content
see: http://www.iac.ethz.ch/edu/courses/master/modules/cloud-microphysics.html

Lecture notes
This course will be designed as a reading course in 1-2 small groups of 8 students maximum. It will be based on the textbook below. The students are expected to read chapters of this textbook prior to the class so that open issues, fascinating and/or difficult aspects can be discussed in depth.

Literature

Prerequisites / notice
Target group: Master students in Atmosphere and Climate

651-4053-05L Boundary Layer Meteorology

Abstract
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

Objective
Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

Content
- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

Lecture notes
available (i.e. in English)
**Literature**


**Prerequisites / notice**

Umwelt-Fluidynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

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**Climate History and Paleoclimatology**

Two courses are offered in autumn semester at University of Berne. ETH courses are only offered in FS.

**Hydrology and Water Cycle**

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<tr>
<th>Number</th>
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<tr>
<td>651-4023-00L</td>
<td>Groundwater</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>M. O. Saar, X.Z. Kong</td>
</tr>
</tbody>
</table>

**Abstract**
The course provides an introduction into quantitative analysis of groundwater flow and solute/heat transport. It is focussed on understanding, formulating, and solving groundwater flow and solute/heat transport problems.

**Objective**
a) Students understand the basic concepts of groundwater flow and solute/heat transport processes and boundary conditions.

b) Students are able to formulate simple, practical groundwater flow and solute/heat transport problems.

c) Students are able to understand and apply simple analytical and/or numerical solutions to fluid flow and solute/heat transport problems.

**Content**
1. Introduction to groundwater problems. Concepts to quantify properties of aquifers.
2. Flow equation. The generalised Darcy law.
3. The water balance equation.
5. Analytical solutions to flow problems I
6. Analytical solutions to flow problems II
7. Finite difference solution to flow problems.
12. Analytical solutions to transport problems I.
13. Analytical solutions to transport problems II

**Lecture notes**
Handouts of slides.

**Literature**
de Marsily G., Quantitative Hydrogeology, Academic Press, 1986

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>102-0287-00L</td>
<td>Fluvial Systems</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Molnar</td>
</tr>
</tbody>
</table>

**Abstract**
The course presents a view of the processes acting on and shaping the landscape and the fluvial landforms that result. The fluvial system is viewed in terms of the production and transport of sediment on hillslopes, the structure of the river network and channel morphology, fluvial processes in the river, riparian zone and floodplain, and basics of catchment and river management.

**Objective**
The course has two fundamental aims: (1) it aims to provide environmental engineers with the physical process basis of fluvial system change, using the right language and terminology to describe landforms; and (2) it aims to provide quantitative skills in making simple and more complex predictions of change and the data and models required.

**Content**
The course consists of three sections: (1) Introduction to fluvial forms and processes and geomorphic concepts of landscape change, including climatic and human activities acting on the system. (2) The processes of sediment production, upland sheet-riill-gully erosion, basin sediment yield, rainfall-triggered landsliding, sediment budgets, and the modelling of the individual processes involved. (3) Processes in the river, floodplain and riparian zone, including river network topology, channel geometry, aquatic habitat, role of riparian vegetation, including basics of fluvial system management. The main focus of the course is hydrological and the scales of interest are field and catchment scales.

**Lecture notes**
There is no script.

**Literature**
The course materials consist of a series of 13 lecture presentations and notes to each lecture. The lectures were developed from textbooks, professional papers, and ongoing research activities of the instructor. All material is on the course webpage.

**Prerequisites / notice**
Prerequisites: Hydrology 1 and Hydrology 2 (or contact instructor).

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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0535-00L</td>
<td>Environmental Soil Physics/Vadose Zone Hydrology</td>
<td>W</td>
<td>3 credits</td>
<td>2G+2U</td>
<td>D. Or</td>
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</table>

The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.
Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection.
- conduct and interpret a limited number of experimental studies.
- explain links between physical processes in the vadose-zone and major societal and environmental challenges.

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity.

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing.

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
Part 1: Laminar flow in tubes (Poiseuille’s Law); Darcy’s Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Part 2: Unsataturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards’ Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.
Midterm exam.

Part 3: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip’s approximations; infiltration rates and wetting front propagation.

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
- Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.
- Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Objective

The lecture provides an introduction to atmospheric chemistry at bachelor level. It introduces the kinetics of gas phase and heterogeneous reactions on aerosols and in clouds and explains the chemical and physical mechanisms responsible for global (e.g. stratospheric ozone depletion) as well as regional (e.g. urban air pollution) environmental problems.

The students will understand the basics of gas phase and heterogeneous reactions and will know the most relevant atmospheric chemical processes taking place in the gas phase as well as between different phases including aerosols and clouds. The students will also acquire a good understanding of atmospheric environmental problems including air pollution, stratospheric ozone destruction and changes in the oxidative capacity of the global atmosphere.

651-2915-00L Seminar in Hydrology Z 0 credits 1S P. Burlando, J. W. Kirchner, S. Löw, D. Or, C. Schär, M. Schirmer, S. I. Seneviratne, M. Stähli, C. H. Stamm, University lecturers

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 135 of 1571
### 701-0042-00L Weather Systems

**Content**
- Origin of properties of the atmosphere: structure, large scale dynamics, UV radiation
- Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of bimolecular and termolecular reactions.
- Tropospheric photochemistry: Photolysis reactions, photochemical O3 formation, role and budget of HOx, dry and wet deposition
- Aerosols and clouds: chemical properties, primary and secondary aerosol sources
- Multiphase chemistry: heterogeneous kinetics, solubility and hygroscopicity, N2O5 chemistry, SO2 oxidation, secondary organic aerosols
- Air quality: role of planetary boundary layer, summer- versus winter-smog, environmental problems, legislation, long-term trends
- Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol
- Global aspects: global budgets of ozone, methane, CO and NOx, air quality - climate interactions

**Objective**
- To introduce the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.
- To explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
- To discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena
- To explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features
- To explain how mountains influence the atmospheric flow on different scales

**Content**
- Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

**Lecture notes**
- Lecture notes and slides

**Literature**
- Atmospheric Science, An Introductory Survey
  - John M. Wallace and Peter V. Hobbs, Academic Press

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### 701-0043-00L Atmospheric Physics

**Abstract**
This course covers the basics of atmospheric physics, which consist of: cloud and precipitation formation, thermodynamics, aerosol physics, radiation as well as the impact of aerosols and clouds on climate and artificial weather modification.

**Objective**
- To explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.
- To evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.

**Content**
- Moist processes/thermodynamics; aerosol physics; cloud formation; precipitation processes, storms; importance of aerosols and clouds for climate and weather modification, clouds and precipitation

**Lecture notes**
- Powerpoint slides and script will be made available

**Literature**

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### 701-0473-00L Numerical Methods in Environmental Sciences

**Abstract**
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Objective**
- Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

**Content**
- Three obligatory exercises, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary: a Matlab introduction is given). Example programs and graphics tools are supplied.

**Lecture notes**
- Is provided (CHF 10.- per copy).

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### Additional Electives ETH

#### Number: 701-0473-00L

#### Title: Numerical Modelling in Fortran

**Abstract**
This course gives an introduction to programming in FORTRAN95, and is suitable for students who have only minimal programming experience. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts.

**Objective**
- FORTRAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

**Lecture notes**
- See http://jupiter.ethz.ch/~pj/FORTRAN/FortranClass.html

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### Minor in Physical Glaciology

#### Number: 101-0289-00L

#### Title: Applied Glaciology

**Abstract**
This course gives an introduction to glaciology, which consists of: the physics of glaciers, the cryospheric environment, ice dynamics, mass balance, and the impact of glaciers on climate change.

**Objective**
- To explain the basic dynamics of glaciers, based on selected glaciological flow phenomena
- To explain how glaciers influence the atmospheric flow on different scales

**Content**
- Glaciers and ice sheets; ice dynamics; mass balance; ice flow and deformation; glacial sliding; ice streams; ice shelves; ice surges; ice age climate

**Lecture notes**
- Lecture notes and slides

**Literature**

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### Course Catalogue of ETH Zurich

#### Minors

#### Minor in Physical Glaciology

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Data: 06.11.2018 12:57

Autumn Semester 2016

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Abstract

We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

Objective

To understand the fundamental physical processes in glaciology.

To learn some basic numerical modelling techniques for glacier flow.

To identify glaciological hazards and to discuss some assessment and mitigation possibilities.

Content

Basics in physical glaciology

Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges

Glacier floods

Ice falls, ice avalanches

Lake ice and bearing capacity

Lecture notes

Handouts are available

Literature

Relevante Literatur wird während der Vorlesung angegeben.

Prerequisites / notice

Für aktuelle Fallbeispiele werden risikobasierte Massnahmen bei glaziologischen Naturgefahren diskutiert.

Voraussetzungen: Es werden Grundkenntnisse in Mechanik und Physik vorausgesetzt.

651-1010-00L Understanding glaciers and ice sheets with simple physical concepts. Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, glacier seismology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.

Objective

After the course the students are able understand and interpret measurements of ice flow, subglacial water pressure and ice temperature.

They will have an understanding of glaciology-related physical concepts sufficient to understand most of the contemporary literature on the topic.

The students will be well equipped to work on glacier-related problems by numerical modeling, remote sensing, and field work.

Content

The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).

Lecture notes

http://peopie.ee.ethz.ch/~luethim/teaching.html

Literature

A list of relevant literature is available on the class web site.

Prerequisites / notice

A list of relevant books and papers will be provided.

Good high school mathematics and physics knowledge required.

651-4077-00L Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)

Objective

Overview of the most important earth surface processes and landforms in cold regions (regions with glaciers and intense frost) with emphasis on high-mountain aspects. Present day research challenges.

Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges.

Erosion and sedimentation by glaciers as a function of topography, englacial temperature, sediment balance, sliding and melt water runoff.

Processes and landforms in regions of seasonal and perennnial frost (frost weathering, rock falls, debris cones/talus, solifluction, permafrost creep, rock glaciers, debris flows).

Glacial and periglacial geomorphodynamics in high-mountain regions. Ca. 100 pages.

Lecture notes

Basic knowledge about geomorphology and glaciers/permafrost from corresponding courses at ETH/UZH or from the related lecture notes will be assumed.

651-1581-00L Seminar in Glaciology

Objective


Lecture notes

Studium aktueller und klassischer Arbeiten der glaziologischen Forschung

Prerequisites / notice

Good high school mathematics and physics knowledge required.

Minor in Biogeochemistry

Number

Title

Type

ECTS

Hours

Lecturers

701-1313-00L Isotopic and Organic Tracers in Biogeochemistry

W

3 credits

2G

R. Kipfer, S. Ladd

Abstract

The course introduces the scientific concepts and typical applications of tracers in biogeochemistry. The course covers stable and radioactive isotopes, geochemical tracers and biomarkers and their application in biogeochemical processes as well as regional and global cycles. The course provides essential theoretical background for the lab course "Isotopic and Organic Tracers Laboratory".

Objective

The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radiogenic isotopes. They discover the spectrum of possible geochemical tracers and biomarkers, their potential and limitations and get familiar with important applications

Content

Geogenic and cosmogenic radionuclides (sources, decay chains; stable isotopes in biogeochemistry (natural abundance, fractionation); geochemical tracers for processes such as erosion, productivity, redox fronts; biomarkers for specific microbial processes.

Lecture notes

Handouts will be provided for every chapter

Literature

A list of relevant books and papers will be provided

Prerequisites / notice

Students should have a basic knowledge of biogeochemical processes (BSc course on Biogeochemical processes in aquatic systems or equivalent)

701-1315-00L Biogeochemistry of Trace Elements

W

3 credits

2G

A. Voegelin, M. Etique, L. Winkel

Abstract

The course addresses the biogeochemical classification and behavior of trace elements, including key processes driving the cycling of important trace elements in aquatic and terrestrial environments and the coupling of abiotic and biotic transformation processes of trace elements. Examples of the role of trace elements in natural or engineered systems will be presented and discussed in the course.

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Autumn Semester 2016
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Objective

The students are familiar with the chemical characteristics, the environmental behavior and fate, and the biogeochemical reactivity of different groups of trace elements. They are able to apply their knowledge on the interaction of trace elements with geosphere components and on abiotic and biotic transformation processes of trace elements to discuss and evaluate the behavior and impact of trace elements in aquatic and terrestrial systems.

Content

(i) Definition, importance and biogeochemical classification of trace elements. (ii) Key biogeochemical processes controlling the cycling of different trace elements (base metals, redox-sensitive and chalcophile elements, volatile trace elements) in natural and engineered environments. (iii) Abiotic and biotic processes that determine the environmental fate and impact of selected trace elements.

Lecture notes

Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

Prerequisites / notice

Students are expected to be familiar with the basic concepts of aquatic and soil chemistry covered in the respective classes at the bachelor level (soil mineralogy, soil organic matter, acid-base and redox reactions, complexation and sorption reactions, precipitation/dissolution reactions, thermodynamics, kinetics, carbonate buffer system).

This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

701-1341-00L Water Resources and Drinking Water

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>W</td>
<td>3</td>
<td>2G</td>
</tr>
</tbody>
</table>

S. Hug, M. Berg, F. Hammes, U. von Gunten

Abstract

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

Objective

The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Content

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Lecture notes

Handouts will be distributed

Literature

Will be mentioned in handouts

701-1346-00L Carbon Mitigation

<table>
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<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>W</td>
<td>3</td>
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</table>

N. Gruber

Abstract

Future climate change can only kept within reasonable bounds when CO2 emissions are drastically reduced. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.

Objective

The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.

Content

From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group.

Lecture notes

None

Literature

Will be identified based on the chosen topic.

Prerequisites / notice

Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.

 Minor in Global Change and Sustainability

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0015-00L</td>
<td>Seminar on Transdisciplinary Research for Sustainable Development</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>C. E. Pohl, M. Stauffacher</td>
</tr>
</tbody>
</table>

Abstract

The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.

Objective

The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

Content

The seminar covers the following topics:

1) Theories and concepts of inter- and transdisciplinary research
2) The specific challenges of inter- and transdisciplinary research
3) Involving stakeholders
4) Collaborating disciplines
5) Exploration of tools and methods
6) Analysing participants' projects to improve inter- and transdisciplinary elements

Literature

Literature will be made available to the participants

Prerequisites / notice

The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.

701-1551-00L Sustainability Assessment

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<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>W</td>
<td>3</td>
<td>2G</td>
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</table>

P. Krüttli, C. E. Pohl

Abstract

The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

Objective

The course is seminar-like, interactive.

Know:

- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:

- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.
Content
The course is structured as follows:
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Trade-offs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

Minor in Sustainable Energy Use

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0551-00L</td>
<td>Energy- and Climate Systems I</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>A. Schlüter</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>The lecture contains concepts, physics and components of building technologies for the efficient and sustainable energy supply and climatisation of buildings and their interaction with architecture and urban design. Using calculations, students learn to acquire relevant numbers and assess the performance of solutions.</td>
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<td>The lecture series focuses on the physical principles and technical components of relevant systems for an efficient and sustainable climatisation and energy supply of buildings. A special focus is on the interrelation of supply systems and architectural design and construction. Learning and practicing methods of quantifying demand and supply allows identifying parameters relevant for design.</td>
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<td>Content</td>
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<tr>
<td></td>
<td>1. Introduction</td>
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<td>2. Heating and cooling</td>
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<td>3. Active and passive ventilation</td>
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<td>4. Electricity in buildings</td>
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<td>Lecture notes</td>
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<td>The Slides from the lecture serve as lecture notes and are available as download.</td>
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<tr>
<td></td>
<td>Literature</td>
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<td>A list of relevant literature is available at the chair.</td>
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<tr>
<td>227-0731-00L</td>
<td>Power Market I - Portfolio and Risk Management</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>D. Reichelt, G. A. Koeppe</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Portfolio and risk management in the electrical power business, Pan-European power market and trading, futures and forward contracts, hedging, options and derivatives, performance indicators for the risk management, modelling of physical assets, cross-border trading, ancillary services, balancing power market, Swiss market model</td>
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<td>1. Pan-European power market and trading</td>
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<td>1.1. Power trading</td>
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<td>1.2. Development of the European power markets</td>
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<td>1.3. Energy economics</td>
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<td>1.4. Spot and OTC trading</td>
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<td>1.5. European energy exchange EEX</td>
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<td>2. Market model</td>
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<td>2.1. Market place and organisation</td>
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<td>2.2. Balance groups / balancing energy</td>
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<td>2.3. Ancillary services</td>
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<td>2.4. Market for ancillary services</td>
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<td>2.5. Cross-border trading</td>
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<td>2.6. Capacity auctions</td>
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<td>3. Portfolio and Risk management</td>
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<td>3.1. Portfolio management 1 (introduction)</td>
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<td>3.2. Forward and futures contracts</td>
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<td>3.3. Risk management 1 (m2m, VaR, hpfc, volatility, cVaR)</td>
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<td>3.4. Risk management 2 (PaR)</td>
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<td>3.5. Contract valuation (HPFC)</td>
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<td>3.6. Portfolio management 2</td>
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<td>2.8. Risk Management 3 (enterprise wide)</td>
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<td>4. Energy &amp; Finance I</td>
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<td>4.1. Options 1 basics</td>
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<td>4.2. Options 2 hedging with options</td>
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<td>4.3. Introduction to derivatives (swaps, cap, floor, collar)</td>
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<td>4.4. Financial modelling of physical assets</td>
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<td>4.5. Trading and hydro power</td>
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<td>4.6. Incentive regulation</td>
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<td>Lecture notes</td>
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<td>Handouts of the lecture</td>
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<td>Prerequisites / notice</td>
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<tr>
<td></td>
<td>1 excursion per semester, 2 case studies, guest speakers for specific topics.</td>
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<td>Course Moodle: <a href="https://moodle-app2.let.ethz.ch/course/view.php?id=2196">https://moodle-app2.let.ethz.ch/course/view.php?id=2196</a></td>
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<tr>
<td>529-0193-00L</td>
<td>Renewable Energy Technologies I</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Wokaun, A. Steinfeld</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Scenarios for the development of world primary energy consumption and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste, CO2 sequestration.</td>
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<td></td>
<td>Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.</td>
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<td></td>
<td>Content</td>
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<td>Lecture notes</td>
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<td>Lecture notes will be distributed electronically during the course.</td>
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</tbody>
</table>
The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

**Prerequisites / notice**

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

### 227-1631-00L Energy System Analysis

<table>
<thead>
<tr>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
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</thead>
</table>

**Abstract**
The course provides an introduction to the methods and tools for analysis of energy consumption, energy production and energy flows. Environmental aspects are included as well as economical considerations. Different sectors of the society are discussed, such as electric power, buildings, and transportation. Models for energy system analysis planning are introduced.

**Objective**
The purpose of the course is to give the participants an overview of the methods and tools used for energy systems analysis and how to use them in simple practical examples.

**Content**
The course gives an introduction to methods and tools for analysis of energy consumption, energy production and energy flows. Both larger systems, e.g. countries, and smaller systems, e.g. industries, homes, vehicles, are studied. The tools and methods are applied to various problems during the exercises. Different conventions of energy statistics used are introduced.

The course provides also an introduction to energy systems models for developing scenarios of future energy consumption and production. Bottom-up and Top-Down approaches are addressed and their features and applications are discussed.

The course contains the following parts:
- Part I: Energy flows and energy statistics
- Part II: Environmental impacts
- Part III: Electric power systems
- Part IV: Energy in buildings
- Part V: Energy in transportation
- Part VI: Energy systems models

**: Handouts**


### Literature

Handouts

**Literature**


### Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>651-4095-01L</td>
<td>Colloquium Atmosphere and Climate 1</td>
<td>O</td>
<td>1 credit</td>
<td>1K</td>
<td>H. Joos, C. Schär, D. N. Bresch, N. Gruber, R. Knutti, U. Lohmann, T. Peter, S. I. Seneviratne, H. Wernli, M. Wild</td>
</tr>
<tr>
<td>651-4095-02L</td>
<td>Colloquium Atmosphere and Climate 2</td>
<td>O</td>
<td>1 credit</td>
<td>1K</td>
<td>H. Joos, C. Schär, D. N. Bresch, N. Gruber, R. Knutti, U. Lohmann, T. Peter, S. I. Seneviratne, H. Wernli, M. Wild</td>
</tr>
<tr>
<td>651-4095-03L</td>
<td>Colloquium Atmosphere and Climate 3</td>
<td>O</td>
<td>1 credit</td>
<td>1K</td>
<td>H. Joos, C. Schär, D. N. Bresch, N. Gruber, R. Knutti, U. Lohmann, T. Peter, S. I. Seneviratne, H. Wernli, M. Wild</td>
</tr>
<tr>
<td>701-1211-01L</td>
<td>Master's Seminar: Atmosphere and Climate 1</td>
<td>O</td>
<td>3 credits</td>
<td>2S</td>
<td>H. Joos, O. Stebler, F. Tummon, M. A. Wüest</td>
</tr>
<tr>
<td>701-1211-02L</td>
<td>Master's Seminar: Atmosphere and Climate 2</td>
<td>O</td>
<td>3 credits</td>
<td>2S</td>
<td>H. Joos, O. Stebler, F. Tummon, M. A. Wüest</td>
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</tbody>
</table>

### Abstract

- In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other's work.
- Training scientific writing skills.
- Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other's work.
- Attendance is mandatory.
- In this seminar scientific project management is introduced and applied to your master project. The course concludes with a presentation of your project including an overview of the science and a discussion of project management techniques applied to your thesis project.

---

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 140 of 1571
Content
In this seminar scientific project management is introduced and applied to your master project. The course concludes with a presentation of your project including an overview of the science and a discussion of project management techniques applied to your thesis project.

Prerequisites / notice
Attendance is mandatory.

701-1213-00L Introduction Course to Master Studies Atmosphere and Climate

Type
ECTS
Hours
Lecturers

O
2
2G
H. Joos, T. Peter

Abstract
New master students are introduced to the atmospheric and climate research field through keynotes given by the programme's professors. In several self-assessment and networking workshops they get to know each other and find their position in the science.

Objective
The aims of this course are i) to welcome all students to the master program and to ETH, ii) to acquaint students with the faculty teaching in the field of atmospheric and climate science at ETH and at the University of Bern, iii) that the students get to know each other and iv) to assess needs and discuss options for training and education of soft-skills during the Master program and to give an overview of the study options in general.

▲ Laboratory and Field Courses

The course in the category «lab and field work» are only offered in spring semester.

▲ Master’s Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4275-00L</td>
<td>Master’s Thesis</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Supervisors</td>
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</tbody>
</table>

Objective
Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;

b. fulfilling of any additional requirements necessary to gain admission to the master programme.

The master thesis is under the supervision of a professor teaching in the module courses of the master programme. Please refer to the web page linked here for instructions and guidelines how to register for the master thesis (http://www.iac.ethz.ch/education/master/curriculum/master_thesis).

Abstract

Objective
Students are to prove their skills in working autonomously on a scientific project. They document their work in a scientific report.

▲ Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0412-AAL</td>
<td>Climate Systems</td>
<td>E-</td>
<td>3</td>
<td>6R</td>
<td>R. Knutti</td>
</tr>
</tbody>
</table>

Objective
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enroll for this course unit.

Lecturer
Reto Knutti, several keynotes to special topics by other professors

Prerequisites / notice
Course taught in German, slides in English

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0471-AAL</td>
<td>Atmospheric Chemistry</td>
<td>E-</td>
<td>3</td>
<td>6R</td>
<td>D. W. Brunner, M. Ammann</td>
</tr>
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</table>

Objective
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enroll for this course unit.

Abstract
This is a self-study course targeted at Master students who did not follow the bachelor course "atmospheric chemistry" or similar. The course provides a general introduction into atmospheric chemistry.

Content
- Origin and properties of the atmosphere: structure, large scale dynamics, UV radiation
- Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of bimolecular and termolecular reactions.
- Tropospheric photochemistry: Photolysis reactions, photochemical C3 formation, role and budget of HOx, dry and wet deposition
- Aerosols and clouds: chemical properties, primary and secondary aerosol sources
- Multiphase chemistry: heterogeneous kinetics, solubility and hygroscopicity, NOx chemistry, SO2 oxidation, secondary organic aerosols
- Air quality: role of planetary boundary layer, summer- versus winter-smog, environment, pollution, legislation, long-term trends
- Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol
- Global aspects: global budgets of ozone, methane, CO and NOx, air quality - climate interactions

Prerequisites / notice
Basic courses in chemistry and physics are expected

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>701-0475-AAL</td>
<td>Atmospheric Physics</td>
<td>E-</td>
<td>3</td>
<td>6R</td>
<td>U. Lohmann</td>
</tr>
</tbody>
</table>

Objective
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.
### 701-0473-AAL Weather Systems

**Enrolment only for MSc students with a decree declaring this course unit as an additional admission requirement.**

**Abstract**

Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; northatlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

**Objective**

Introduction to basic aspects of atmospheric dynamics. Focus is given to the global-scale atmospheric circulation, synoptic-scale processes (in particular low-pressure systems), and the influence of mountains on the atmospheric flow.

**Content**

Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

**Lecture notes**

Lecture notes and slides

**Literature**

Atmospheric Science, An Introductory Survey

John M. Wallace and Peter V. Hobbs, Academic Press

<table>
<thead>
<tr>
<th>3 credits</th>
<th>6R</th>
<th>M. A. Sprenger, C. Grams</th>
</tr>
</thead>
</table>

### 701-0461-AAL Numerical Methods in Environmental Sciences

**Enrolment only for MSc students with a decree declaring this course unit as an additional admission requirement.**

**Abstract**

This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Objective**

This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Content**

Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Three obligatory exercises, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary: a Matlab introduction is given). Example programs and graphics tools are supplied.

**Lecture notes**

Lecture notes and slides

**Literature**

List of literature is provided.

<table>
<thead>
<tr>
<th>3 credits</th>
<th>6R</th>
<th>C. Schär, O. Fuhrer</th>
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</table>

### 701-1901-AAL Systems Analysis

**Enrolment only for MSc students with a decree declaring this course unit as an additional admission requirement.**

**Abstract**

Self study course in Systems Analysis to fulfill requirements for enrollment into the master program. Topics covered include linear box models with one and several variables; non-linear box models with one or several variables; discrete-time models; and continuous models in space and time.

**Objective**

The aim of this course is to develop an understanding of the dynamical behavior of environmental systems and how this behavior can be captured and understood using mathematical concepts.

**Lecture notes**

For English Speaking students:


<table>
<thead>
<tr>
<th>4 credits</th>
<th>6R</th>
<th>N. Gruber</th>
</tr>
</thead>
</table>

### 701-0106-AAL Mathematics V: Applied Deepening of Mathematics I - III

**Enrolment only for MSc students with a decree declaring this course unit as an additional admission requirement.**

**Abstract**

Selected mathematical topics are presented for later use in more specialised lectures. Part of the topics were already discussed in the lectures Mathematics I-III. Here, they should be shortly recapitulated and most importantly applied to practical problems. If necessary, new mathematical concepts and methods will be introduced in order to solve challenging and inspiring problems from practice.

**Objective**

The aim of this lecture is to prepare the students for the more specialised lectures. They should become more familiar with the mathematical background, the mathematical concepts and most of all with their application and interpretation.

**Content**

Practical examples from the following areas will be discussed: ordinary differential equations; eigenvalue problems from linear algebra; systems of linear and nonlinear differential equations; partial differential equations (diffusion, transport, waves).
<table>
<thead>
<tr>
<th>Key for Type</th>
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<tbody>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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</table>

<table>
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<tr>
<th>Key for Hours</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS | European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
In this class, students will learn concepts and skills for coping with psychosocial demands of teaching. ECTS

A. Deiglmayr

Cognitively Activating Instructions in MINT Subjects

E. Stern, P. Edelsbrunner

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of ETH Zurich. In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (LZH).

Prerequisites:

Number of participants limited to 20.

Literature


Prerequisites / notice

This course is only apt for students who intend to enrol in the programs "Lehrdiplom" or "Didaktisches Zertifikat". It is about learning in childhood and adolescence.

Human Learning (EW1)

This lecture is only apt for students who intend to enrol in the programs "Teaching Diploma" or "Teaching Certificate". It is about learning in childhood and adolescence.

Abstract

This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

Objective

Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

Content

Thematic Schwerpunkte:

Lernen als Verhaltensänderung und als Informationsverarbeitung; Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzaufbau unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien, Geschlechtsunterschiede beim Lernen

Lernformen:


Abstract

In this class, students will learn concepts and skills for coping with psychosocial demands of teaching

Objective

Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).

(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

Colloquium on the Science of Learning and Instruction

In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (LZH).

Prerequisites:

Number of participants limited to 20.

Literature

U. Markwalder

Coping with Psychosocial Demands of Teaching (EW4 W

D2) ■

Number of participants limited to 20.

The successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

Abstract

In this class, students will learn concepts and skills for coping with psychosocial demands of teaching

Objective

Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).

(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

Cognitively Activating Instructions in MINT Subjects ■

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

Abstract

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective

- Get to know cognitively activating instructions in MINT subjects

- Get information about recent literature on learning and instruction

Prerequisites:

Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht

Human Intelligence

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

Abstract

The focus will be on the book "Intelligenz: Große Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.
Objective
- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

851-0242-08L Research Methods in Educational Science  W 1 credit 1S P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract
Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objective
- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

851-0240-03L Introduction to Test Theory and Test Construction in Educational Contexts (University of Zürich)  W 4 credits 2S University lecturers
Enrollment only possible with Teaching Diploma or DC matriculation.

No enrollment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: 200a968
Mind the enrollment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
In this seminar, students establish the scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.

Objective
At the end of the seminar, participants will be in a position to
- describe the scientific fundamentals of test theory and test structure,
- evaluate examples of scientifically-developed tests in their application context,
- if necessary, critically question the performance assessment that they employ in practice and professionalise it still further.

Content
Die konkreten Inhalte des Seminars ergeben sich aufgrund der Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:
- Testentwicklung
- Gütekriterien von Tests
- Aufgabenkonstruktion
- Datenauswertung
- Rasch-Modell
- Internationale Vergleichstests
- Zulassungs tests

Lecture notes
Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören auch die Handouts der verschiedenen, studentischen Vorträge.

Literature
Als Grundlagenliteratur werden folgende Werke empfohlen:
- Weitere Literatur wird in der Lehrveranstaltung genannt.

Prerequisites / notice
Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben.
Dazu sind folgende Leistungen zu erbringen:
- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)
- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung
- Referat (RE)
- Schreiben einer schriftlichen Arbeit

Weitere Angaben zu den Leistungsanforderungen werden im Rahmen der Startveranstaltung abgegeben und erläutert.

Educational Science Teaching Diploma

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<tr>
<th>Number</th>
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<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
</tbody>
</table>

This lecture is only apt for students who intend to enrol in the programs "Teaching Diploma" or "Teaching Certificate". It is about learning in childhood and adolescence.

Abstract
This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

Objective
Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

Content
Thematische Schwerpunkte:
- Lernen als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien, Geschlechtsunterschiede beim Lernen
- Lernformen:

Lecture notes
Folien werden zur Verfügung gestellt.
The students have to read the book "Lernwirksam unterrichten" from Felten/Stern and they have to answer the questions addressed on

**Main goals are:**

- Coping with Psychosocial Demands of Teaching
- Effective Learning Environments
- Designing Educational Environments

**L. Schalk**
3 credits
Students know and practice techniques and skills for coping with psychosocial demands of teaching.

Slides of the lecturer's presentations, supplementary materials, and materials for further reading are made available on Moodle.

**3S**
Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

**Designing Educational Environments in Physical Education (EW2 Sport)**

- Compulsory course requirements for EW2 Sport: This course is required to be taken prior to EW4 Sport

**Support and Diagnosis of Knowledge Acquisition Processes (EW3)**

Enrolment only possible with matriculation in Teaching Diploma (except for students of Sport Teaching Diploma, who complete the sport-specific course unit EW3) and for students who want to enrol in the "Teaching Diploma".

Prerequisites: successful participation in 851-0240-00L "Human Learning (EW1)".

**Content**

- counseling and counselling techniques
- conflict management and mediation
- classroom management
- supporting students in a psychological crisis
- preventing stress and burnout

Forms of learning

Theoretical foundations will be taught in workshops which contain different means of activation and interaction such as group work, panel discussions, and individual work. Subsequently, this knowledge will be transferred and applied in different school-relevant situations by means of role plays, discussing of cases and video sequences, as well as reflections of practical experiences.

**Lectures notes**

Slides of the lecturer's presentations, supplementary materials, and materials for further reading are made available on Moodle.

**Literature**

Verschiedenen Grundlagen- und Anwendungstexte werden den Studierenden zur Verfügung gestellt.

**Prerequisites / notice**

Der erfolgreiche Abschluss von EW1 und EW2 stellt eine wünschenswerte, jedoch nicht obligatorische Voraussetzung dar.

**851-0238-01L**

**Support and Diagnosis of Knowledge Acquisition Processes (EW3)**

Enrolment only possible with matriculation in Teaching Diploma (except for students of Sport Teaching Diploma, who complete the sport-specific course unit EW3) and for students who want to enrol in the "Teaching Diploma".

Prerequisites: successful participation in 851-0240-00L "Human Learning (EW1)".

**Objective**

In this seminar students learn advanced techniques to support and to diagnose knowledge acquisition processes in school.

The main goals are:

1. You have a deep understanding about the cognitive mechanisms of knowledge acquisition.
2. You have a basic understanding about psychological test theory and can appropriately administer tests.
3. You know various techniques of formative assessment and can apply these to uncover students' misconceptions.

**Prerequisites / notice**

Für eine reibungslose Semesterplanung wird um persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

**851-0240-15L**

**Designing Educational Environments in Physical Education (EW2 Sport)**

Compulsory course requirements for EW2 Sport: This course is required to be taken prior to EW4 Sport

"Outdoor Education: Concepts and Practice" (851-0242-02L)

**Objective**

Students know and apply principles of teaching beyond classroom and regular PE-Lessons:

- Teaching the "Ergänzungsfach Sport"
- Long-term-curricula in PE

As a practical part students design the Outdoor event in EW4 of the following term

1. LV Semestereinführung
2. LV Planung Outdoor-Weekend
3. LV Auswertung Outdoor-Event
4. LV Planung Event
5. LV Event-Präsentationen / Schlussveranstaltung

**Content**

- How to plan events and camps
- To assess curricula critically and to use them properly
- How to combine theoretical and practical issues in the 'Ergänzungsfach'
- classroom management
- conflict management and mediation
- counseling and counseling techniques

**851-0240-19L**

**Effective Learning Environments (EW 5)**

This is a mandatory course for students of the teacher's diploma for secondary schools, who have not completed the course 851-0238-01L. "Unterstützung und Diagnose von Wissenswertsprozessen" (EW 3) until the end of spring semester 2014 (except for students of Sport Teaching Diploma, who have completed the sport-specific course units EW2-4).

The successful completion of ALL modules relevant for the teacher's diploma is required for participation in this course.

**Objective**

The students have to read the book "Lernwirksam unterrichten" from Felten/Stern and they have to answer the questions addressed on http://www.lvl.ethz.ch/studium/lehre/ew-5.html. In individual or small-group sessions, Elisabeth Stern and the students will discuss how insights from learning research can inform classroom practice.

**Prerequisites / notice**

This is only apt for students who intend to enrol in the programs "Lehrdiplom" or "Didaktisches Zertifikat". It is about learning in childhood and adolescence.
Student teachers will develop an understanding of the concepts of nature of science and scientific inquiry. They will design a variety of student research projects: practical research on learning and instruction. This seminar will begin with a review of the literature on the teaching and learning of nature of science and scientific inquiry. It focuses on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

Objective
- Understanding of research methods used in the empirical sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

Prerequisites
- Non-students admitted by special arrangement

Literature
Buch "Lernwirksam unterrichten" (Felten/Stern)
Detailed information: http://www.ifvll.ethz.ch/studium/lehre/ew-5.html

851-0242-07L Human Intelligence  1 credit  1S  E. Stern, P. Edelsbrunner, B. Rütsche

Abstract
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

Objective
- Understanding of research methods used in the empirical human sciences
- Understanding findings relevant for education

Prerequisites
- Non-students admitted by special arrangement


Abstract
The successful completion of both course no. 851-0240-00L "Menschliches Lernen (EW 1)" and course no. 851-0239-01L "Unterstützung und Diagnose von Wissenswertsprozessen (EW 3)" is a necessary prerequisite for this course.

Objective
- Participants can summarize and evaluate the main results from a study in the field of learning and instruction, with regard to the research question being asked.

Prerequisites
- Non-students admitted by special arrangement

851-0242-06LCogitively Activating Instructions in MINT Subjects  2 credits  2S  R. Schumacher

Abstract
This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective
- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites
- Non-students admitted by special arrangement

851-0242-08L Research Methods in Educational Science  1 credit  1S  P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler

Abstract
Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objective
- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

851-0250-05L Introduction to "Nature of Science" and "Scientific Inquiry"  1 credit  1S  J. Egli
Formulating learning objectives at different levels, and implementing and monitoring these.

Positionierung des Berufsfachschulunterrichts innerhalb des dualen (trialen) Systems.

Handouts vom Dozenten und Sammlung von Arbeitsmaterialien auf dem BSCW-Server.

“The Vocational Schools as Sites of Teaching and Learning - Teaching Structure” sets out and discusses how to implement the specifications in the framework curriculum. This module is aimed at teachers in high schools awarding vocational school-leaving certificates (Berufsmaturitaet) and all types of vocational schools. It also covers the link established with the company as a learning location.

851-0237-01L Vocational Schools as Sites of Teaching and Learning I: Teaching Structure (University of Zürich) Enrolment only possible with Teaching Diploma matriculation.

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

Simultaneous enrolment in course “Lehr- und Lernort Berufsfachschule II: Förderung und Unterstützung von Lernenden” (UZH Module Code: 090LLB2) is compulsory.

Mind the enrolment deadlines at UZH:

http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

"The Vocational Schools as Sites of Teaching and Learning - Teaching Structure” sets out and discusses how to implement the specifications in the framework curriculum. This module is aimed at teachers in high schools awarding vocational school-leaving certificates (Berufsmaturitaet) and all types of vocational schools. It also covers the link established with the company as a learning location.

Objective

- Formulating learning objectives at different levels, and implementing and monitoring these.
- Steering tuition in terms of content and method to fit in with the objectives.
- Formulating examination questions and assignments on the basis of the learning objectives set out in the curriculum and the teaching given.
- Selectively deploying different examination types and procedures/structuring selected learning contents logically in terms of the subject matter and learning process (from the concrete to the abstract, from the simple to the complex) and implementing these with different didactic visual aids.

Content

In der Veranstaltung werden die Rahmen- und Schullehrpläne der Berufsmaturitaet (alle Richtungen) analysiert und deren Fachinhalten in Übungen und Hospitalationen didaktisch umgesetzt. Der Unterricht an der Berufsmaturitaet wird im Hinblick auf die Herausforderung "Viel Stoff-wenig Zeit" erarbeitet.

Lecture notes

Von den Dozierenden.

Literature

Unterrichten an Berufsfachschulen: Berufsmaturitaet. hep Verlag Bern


G. Steiner (2207): Der Kick zum effizienten Lernen. hep Verlag

Rahmen- und Schullehrpläne der Berufsmaturitaet

Prerequisites / notice

Die Lehrveranstaltung ist seit September 2008 vom Bundesamt für Berufsbildung und Technologie akkreditiert.

851-0237-02L Vocational Schools as Sites of Teaching and Learning II: Providing Encouragement & Support (UZH) Enrolment only possible with Teaching Diploma matriculation.

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

Simultaneous enrolment in course “Lehr- und Lernort Berufsfachschule I: Unterrichtsgestaltung” (UZH Module Code: 090LLB1) is compulsory.

Mind the enrolment deadlines at UZH:

http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

The module "vocational schools as sites of teaching and learning: providing encouragement and support for apprentices" aims to provide teachers at VET and professional baccalaureate institutions with ways of dealing with learners problems, particularly in connection with their being fed up with school, with job-seeking, school-to-work transition, or continuing education.

Objective

- Die spezielle Situation der Berufsschüler/innen in ihrer Doppelbelastung Beruf und Schule wahrnehmen und pädagogisch berücksichtigen können.
- Die Übertrittsthematik in Bezug auf die Leistungsmotivation kennenlernen: Mit Konflikten, Störungen und allgemein schwierigen Situationen im BM-Unterricht lösungsorientiert umgehen können.
- Das lösungsorientierte Konfliktgespräch in schulischen Kontext / Beratung und Coaching: Beratungssituationen im Kontext des Konfliktmanagements lösungsorientiert umgehen können.
- Positivierung der Berufsfachschulinrichtungen innerhalb des dualen (trialen) Systems.
- Berufsmaturitaet: Entwicklung von Kernkompetenzen für die Wirtschaft?
- "Verakademisierung" der Berufsbildung?
- Sozialisations- und Lernprozesse im beruflichen Umfeld / Führungsverständnis im Umgang mit Jugendlichen an Berufsfachschulen.
- Konfliktmanagement I: Wahrnehmungsinstrumente und Interventionssstrategien, Konfliktprävention und niederchwelliges Konfliktmanagement.
- Rollenverständnis und Rollengrenzen. Berufsschüler/innen im Umgang mit Störungen.
- Mobbing in der Schule. Konzepte und Praxis der betrieblichen Betreuung und Förderung.
- Jugendkriminalität und Jugendgewalt.
- Jugendkrisen und Krisenintervention.

Lecture notes

Handouts vom Dozenten und Sammlung von Arbeitsmaterialien auf dem BSCW-Server.
At the end of the seminar, participants will be in a position to:

- Get to know cognitively activating instructions in MINT subjects

In this seminar, students establish the scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.

Die konkreten Inhalte des Seminars ergeben sich aufgrund der Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht für Vorträge und Seminarsarbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:

- Testentwicklung
- Gütekriterien von Tests
- Aufgabenkonstruktion
- Datenauswertung
- Rasch-Modell
- Internationale Vergleichtests
- Zulassungstests

Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.

<table>
<thead>
<tr>
<th>851-0240-03L</th>
<th>Introduction to Test Theory and Test Construction in Educational Contexts (University of Zürich)</th>
<th>W</th>
<th>4 credits</th>
<th>2S</th>
<th>University lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Enrolment only possible with Teaching Diploma or DC matriculation.</td>
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<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.</td>
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<tr>
<td></td>
<td>UZH Module Code: 200a968</td>
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<tr>
<td></td>
<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
<td></td>
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</table>

Prerequisites / notice

Die Lehrveranstaltung ist seit September 2008 vom Bundesamt für Berufsbildung und Technologie akkreditiert.

<table>
<thead>
<tr>
<th>851-0240-16L</th>
<th>Colloquium on the Science of Learning and Instruction</th>
<th>W</th>
<th>1 credit</th>
<th>1K</th>
<th>E. Stern, P. Greutmann, further lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abstract: In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH).</td>
<td></td>
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<tr>
<td></td>
<td>Objective: Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>851-0242-06L</th>
<th>Cognitively Activating Instructions in MINT Subjects</th>
<th>W</th>
<th>2 credits</th>
<th>2S</th>
<th>R. Schumacher</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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</tbody>
</table>

Abstract

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective

- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites / notice

Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

<table>
<thead>
<tr>
<th>851-0242-07L</th>
<th>Human Intelligence</th>
<th>W</th>
<th>1 credit</th>
<th>1S</th>
<th>E. Stern, P. Edelsbrunner, B. Rutsche</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td></td>
<td>Number of participants limited to 30. This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
<td></td>
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</tbody>
</table>

Prerequisites / notice

Die Lehrveranstaltung ist seit September 2008 vom Bundesamt für Berufsbildung und Technologie akkreditiert.
Abstract
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

Objective
- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Seminar</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
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</tbody>
</table>

**Number of participants limited to 30**

This course can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)"

**Abstract**

Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

**Objective**

- Understand research methods used in the empirical educational sciences
- Understand and critically examine evidence from empirical studies and journals
- Understand pedagogically relevant findings from the empirical educational sciences

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<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Seminar</th>
<th>Instructor(s)</th>
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</tbody>
</table>

**Number of participants limited to 20**

The successful completion of both course no. 851-0240-00L "Menschliches Lernen (EW 1)" and course no. 851-0238-01L "Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)" is a necessary prerequisite for this course.

**Abstract**

In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.

**Objective**

The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning & Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students' independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)

**Objective**

- Understand pedagogically relevant findings from the empirical educational sciences
- Understand and critically examine evidence from empirical studies and journals
- Understand pedagogically relevant findings from the empirical educational sciences

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Seminar</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0250-05L</td>
<td>Introduction to &quot;Nature of Science&quot; and &quot;Scientific Inquiry&quot;</td>
<td>1 credit</td>
<td>1S</td>
<td>J. Egli</td>
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</table>

**Enrolment only possible with matriculation in Teaching Diploma (excluding Teaching Diploma Sport),**

**Abstract**

This seminar will begin with a review of the literature on the teaching and learning of nature of science and scientific inquiry. It focuses on the development of adequate and functional understandings of nature of science and scientific inquiry.

**Objective**

Student teachers will develop an understanding of the concepts of nature of science and scientific inquiry. They will design a variety of instructional materials for teaching students about these concepts.

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Seminar</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td>851-0594-00L</td>
<td>International Environmental Politics</td>
<td>3 credits</td>
<td>2V</td>
<td>T. Bernauer</td>
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</tbody>
</table>

**Particularly suitable for students of D-ITET, D-USYS**

**Abstract**

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

**Objective**

- Study the objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy domain and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

**Content**

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

**Lecture notes**

Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike.Hudecheck@ib.ethz.ch). All assigned papers must be read ahead of the respective meeting. Following the course on the basis of on-line slides and papers alone is not sufficient. Physical presence in the classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GESS library at ETH Zurich, Haldeneggstrasse 4, B-floor, or in the library of D-USYS.

**Literature**

Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike.Hudecheck@ib.ethz.ch).
Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times dealt with this issue? The lecture covers the following main topics: Social perception and interpersonal judgement; attitudes; group dynamics and group performance; leadership behavior and leadership styles.

### Prerequisites / notice

None

### Example Content

The participants should develop competencies in the structuring of communication, interaction, and management processes.

- an den Beispielen von Kaufverhalten oder ökologischem Verhalten zu beschreiben, wie Normen und Einstellungen Einfluss auf das Verhalten nehmen.
- Die Subjektivität und die Fehlerquellen sozialer Wahrnehmung verstehen.
- Prinzipien der Psychologie der Kommunikation zu nutzen für eine Verbesserung der Kommunikation in Studium und Beruf.
- Merkmale und Strukturen von Gruppen zu identifizieren und mit geeigneten Methoden zu analysieren.
- Die Grundlagen von Konformität und Gehorsam gegenüber Autoritäten zu erkennen.
- Gruppenphänomene wie soziales Faulenzen, Risiko- und Konservatismus-Schub und Gruppenüberwundenheit zu entdecken.
- Decisionleistungen und -entscheidungen zu optimieren.
- Führungsstile zu unterscheiden lernen.
- Techniken zur Moderation von interagierenden Gruppen kennenzulernen.

### Literature

- Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.

### Further Information

- A reader will be available for students.
- Further optional exercises accompany the lecture and offer the opportunity for an in-depth discussion of selected texts from the reader. Students receive an additional credit point. They have to sign up separately for the exercises for the course 701-0701-01 U.
- Students are asked to write an exam during the second last session (11.12.2015).

### Prerequisites / notice

None
corresponding module directly at UZH.
UZH Module Code: 090MzgU

Enrolment only possible with matriculation in Teaching Diploma or TC at ETH or in Teaching Diploma at UZH.

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Students are familiarised with the subjects taught at high-school level I (the first three years of the full-length high school, or the first year of the reduced-length high school). The central contents of geometry, arithmetic and algebra, and also written mathematical problems are explained.

Objective
In the teaching given at high-school level I (the first three years of the full-length high school or the first year of the reduced-length high school), central concepts and approaches adopted in mathematics are introduced and observed in greater depth. These include variables, function, proof. This calls for a careful didactic analysis on the part of the teacher, requiring them to study and reflect on the prerequisites for the pupils and the requirements in terms of mathematics and cognitive psychology.

Content
Beispiele von Schülerarbeiten geben in diesem Seminar einen Einblick in die mathematische Denkwelt der Schülerinnen und Schüler. Vielfältige Aufgaben zum Einsatz im Unterricht werden vorgestellt, selber gelöst und diskutiert.

- Arithmetik und Algebra: Zahlbereiche, Form und Inhalt in der Algebra.
- Geometrie: Konstruieren-Berechnen-Beweisen, dynamische Geometrie (GeoGebra).
- Sachrechnen: Funktionsbegriff, mathematische Modellierung.
- Aktuelle mathematikdidaktische Aspekte wie Lernprozesse, Grundvorstellungen, Kompetenzen, offene Aufgaben.

Lecture notes
Zahlreiche begleitende Unterlagen werden abgegeben.

Prerequisites / notice
Seminar mit Übungen

Educational Science for Teaching Diploma and TC - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-1187-00L</td>
<td>Colloquium in Structural Engineering</td>
<td>E-</td>
<td>0 credits</td>
<td>2K</td>
<td>B. Stojadinovic, E. Chatzi, M. Fontana, A. Frangi, W. Kaufmann, B. Sudret, T. Vogel</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Professors from national and international universities, technical experts from the industry as well as research associates of the institute of structural engineering (IBK) are invited to present recent research results and specific projects from the practice. This colloquium is addressed to members of universities, practicing engineers and interested persons in general.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Learn about recent research results in structural engineering.</td>
</tr>
<tr>
<td>101-1387-00L</td>
<td>Colloquia in Geotechnics</td>
<td>E-</td>
<td>0 credits</td>
<td></td>
<td>A. Puzrin, G. Anagnostou, I. Anastasopoulos</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>The Institute for Geotechnical Engineering invites distinguished speakers from research and practice, nationally and internationally. The colloquia are directed towards staff and students from Universities as well as engineers and scientists working in industry. Details can be obtained from <a href="http://www.igt.ethz.ch">www.igt.ethz.ch</a> by following Events &amp; Public Events. Some colloquia are available via webcast.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
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<td></td>
<td>Learn about recent research results in geotechnics.</td>
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### Civil Engineering (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E- Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr Suitable for doctorate</td>
</tr>
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</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>Practical/laboratory course</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A Independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D Diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R Revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td>ECTS European Credit Transfer and Accumulation System</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>■</td>
<td>Special students and auditors need special permission from the lecturers.</td>
</tr>
<tr>
<td>Number</td>
<td>Title</td>
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<tr>
<td>----------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>401-0241-00L</td>
<td>Analysis I</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
</tr>
<tr>
<td></td>
<td>Mathematical tools for the engineer</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
</tr>
<tr>
<td></td>
<td>Basic mathematical knowledge for engineers.</td>
</tr>
<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Complex numbers</td>
</tr>
<tr>
<td></td>
<td>Calculus for functions of one variable with applications.</td>
</tr>
<tr>
<td></td>
<td>Simple Mathematical models in engineering.</td>
</tr>
<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
</tr>
<tr>
<td></td>
<td>Die Vorlesung folgt weitgehend</td>
</tr>
<tr>
<td></td>
<td><strong>Literature</strong></td>
</tr>
<tr>
<td></td>
<td>Meike Akveld, &quot;Analysis 1&quot;, vdf:</td>
</tr>
<tr>
<td></td>
<td>Urs Stammbach, &quot;Analysis III&quot; (erhältlich im ETH Store);</td>
</tr>
<tr>
<td>401-0141-00L</td>
<td>Linear Algebra and Numerical Analysis</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
</tr>
<tr>
<td></td>
<td>Introduction to Linear Algebra and Numerical Analysis with emphasis on both abstract concepts and algorithms.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
</tr>
<tr>
<td></td>
<td>To acquire basic knowledge of Linear Algebra and Numerical Methods. Enhanced capability for abstract and algorithmic thinking based on mathematical concepts and models. Ability to select appropriate numerical linear algebra methods, to apply them properly and to implement them efficiently in MATLAB.</td>
</tr>
<tr>
<td></td>
<td><strong>Content</strong></td>
</tr>
<tr>
<td></td>
<td>1. Linear systems of equations</td>
</tr>
<tr>
<td></td>
<td>2. Vector and matrix calculus</td>
</tr>
<tr>
<td></td>
<td>3. Subspaces and bases</td>
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<tr>
<td></td>
<td>4. The Euclidean space Rn</td>
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<tr>
<td></td>
<td>5. Numerical linear algebra with MATLAB</td>
</tr>
<tr>
<td></td>
<td>6. Linear mappings (optional)</td>
</tr>
<tr>
<td></td>
<td>7. Diagonalization (eigenproblems)</td>
</tr>
<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Literature</strong></td>
</tr>
<tr>
<td></td>
<td>K. Nipp, D. Stoffer, Lineare Algebra, VdF Hochschulverlag ETH</td>
</tr>
<tr>
<td></td>
<td>G. Strang, Lineare Algebra, Springer</td>
</tr>
<tr>
<td>252-0845-00L</td>
<td>Computer Science I</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
</tr>
<tr>
<td></td>
<td>The course covers the basic concepts of computer programming.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
</tr>
<tr>
<td></td>
<td>Basic understanding of programming concepts. Students will be able to write and read simple programs and to modify existing programs.</td>
</tr>
<tr>
<td></td>
<td><strong>Content</strong></td>
</tr>
<tr>
<td></td>
<td>Variablen, Typen, Kontrollanweisungen, Prozeduren und Funktionen, Scoping, Rekursion, dynamische Programmierung, vektorisierte Programmierung, Effizienz.</td>
</tr>
<tr>
<td></td>
<td>Als Lernsprachen werden Pascal und Matlab verwendet.</td>
</tr>
<tr>
<td>151-0501-00L</td>
<td>Mechanics 1: Kinematics and Statics</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
</tr>
<tr>
<td></td>
<td>Basics: Position of a material point, velocity, kinematics of rigid bodies, forces, reaction principle, mechanical power</td>
</tr>
<tr>
<td></td>
<td>Statics: Groups of forces, moments, equilibrium of rigid bodies, reactions at supports, parallel forces, center of gravity, statics of systems, principle of virtual power, trusses, frames, forces in beams and cables, friction</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
</tr>
<tr>
<td></td>
<td>The understanding of the fundamentals of statics for engineers and their application in simple settings.</td>
</tr>
<tr>
<td></td>
<td><strong>Content</strong></td>
</tr>
<tr>
<td></td>
<td>Grundlagen: Lage eines materiellen Punktes; Geschwindigkeit; Kinematik starrer Körper, Translation, Rotation, Kreiselung, ebene Bewegung; Kräfte, Reaktionsprinzip, innere und äussere Kräfte, verteilte Flächen- und Raumkräfte; Leistung</td>
</tr>
<tr>
<td></td>
<td>Statik: Äquivalenz und Reduktion von Kräftegruppen; Ruhe und Gleichgewicht; Hauptsatz der Statik; Lagerbindungen und Lagerkräfte, Lager bei Balkenträger und Wellen, Vorgehen zur Ermittlung der Lagerkräfte; Parallele Kräfte und Schwerpunkt; Statik der Systeme, Behandlung mit Hauptsatz, mit Prinzip der virtuellen Leistungen, statisch unbestimmte Systeme; Statisch bestimmte Fachwerke, ideale Fachwerke, Pendelstützen, Knotengleichgewicht, räumliche Fachwerke; Reibung, Haftreibung, Gleitreibung, Gelenk und Lagerreibung, Rollreibung; Seilstatik; Beanspruchung in Stabträgern, Querkraft, Normalkraft, Biege- und Torsionsmoment</td>
</tr>
<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
</tr>
<tr>
<td></td>
<td>Übungsblätter</td>
</tr>
<tr>
<td></td>
<td><strong>Literature</strong></td>
</tr>
<tr>
<td></td>
<td>Sayir, M.B., Dual J., Kaufmann S., Ingenieurmechanik 1; Grundlagen und Statik, Teubner</td>
</tr>
<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
</tr>
<tr>
<td></td>
<td>Written session examination in &quot;Mechanics 1&quot; and &quot;Mechanics 2&quot; for D-MAVT Students, Students in Human Movement Sciences and Sport and all other Students, who take &quot;Mechanics 1&quot; and &quot;Mechanics 2&quot;:</td>
</tr>
<tr>
<td></td>
<td>Part 1: 20 minutes: Neither notes nor calculators allowed right afterwards:</td>
</tr>
</tbody>
</table>

651-0032-00L | Geology and Petrography                   | O    | 4 credits | 2V+1U | C. A. Heinrich, S. Löw, |
This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.

Lecture notes
The course is based on the book Dynamic Earth from Press & Siever

Literature
Press, F.; Siever, R.: Allgemeine Geologie, Spektrum Akademischer Verlag, Heidelberg

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851-0703-03L
Introduction to Law for Civil Engineering

- Only for Civil Engineering BSc, Geomatic Engineering and Planning BSc, Environmental Engineering BSc and Spatial Development and Infrastructure Systems MSc

Objective

Content
Le cours de droit civil porte notamment sur le droit des obligations (droit des contrats et responsabilité civile) et sur les droits réels (propriété, gages et servitudes). De plus, il est donné un bref aperçu du droit de la procédure et de l'exécution forcée.

Literature
Editions officielles récentes des lois fédérales, en langue française (Code civil et Code des obligations) ou italienne (Codice civile e Codice delle obbligazioni), disponibles auprès de la plupart des librairies.

- Boillod, J.-P.: Manuel de droit, éd Slatkine, Genève
- Nef, Urs Ch.: Le droit des obligations à l'usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
- Boillod, J.-P.: Manuel de droit, éd Slatkine, Genève

Prerequisites / notice
- Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours “Recht I” et “Recht II” en langue allemande et des exercices y relatifs.
- Les examens peuvent se faire en français ou en italien.
- Examen au 1er propédeutique; convient pour travail de semestre.

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851-0709-00L
Introduction to Civil Law

Objective

Content
Le cours de droit civil porte notamment sur le droit des obligations (droit des contrats et responsabilité civile) et sur les droits réels (propriété, gages et servitudes). De plus, il est donné un bref aperçu du droit de la procédure et de l'exécution forcée.

Literature
Editions officielles récentes des lois fédérales, en langue française (Code civil et Code des obligations) ou italienne (Codice civile e Codice delle obbligazioni), disponibles auprès de la plupart des librairies.

- Boillod, J.-P.: Manuel de droit, éd Slatkine, Genève
- Nef, Urs Ch.: Le droit des obligations à l'usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
- Boillod, J.-P.: Manuel de droit, éd Slatkine, Genève

Prerequisites / notice
- Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours “Recht I” et “Recht II” en langue allemande et des exercices y relatifs.
- Les examens peuvent se faire en français ou en italien.
- Examen au 1er propédeutique; convient pour travail de semestre.

---

Optional Colloquia

Compulsory Courses 3. Semester

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Examination Block 1

Number
401-0243-00L

Title
Analysis III

Type
O

ECTS
3

Hours
2V+1U

Lecturers
M. Larsson
The course teaches the basics of hydromechanics, relevant for civil and environmental engineers. We will model and solve scientific problems with partial differential equations. Differential equations which are important in applications will be classified and solved. Elliptic, parabolic and hyperbolic differential equations will be treated. The following mathematical tools will be introduced: Laplace and Fourier transforms, Fourier series, separation of variables, methods of characteristics.

Objective
Learning to model scientific problems using partial differential equations and developing a good command of the mathematical methods that can be applied to them. Knowing the formulation of important problems in science and engineering with a view toward civil engineering (when possible). Understanding the properties of the different types of partial differential equations arising in science and in engineering.

Content
Classification of partial differential equations

Study of the Heat equation general diffusion/parabolic problems using the following tools:
* Separation of variables
* Fourier series
* Fourier transform
* Laplace transform

Study of the wave equation and general hyperbolic problems using similar tools and the method of characteristics.

Lecture notes
Study of the Laplace equation and general elliptic problems using similar tools and generalizations of Fourier series.

We will loosely follow the following books:

Stanley J. Farlow - Partial Differential Equations for Scientists and Engineers (a Dover reprint and can be bought for less than 20 CHF)

Chapters 11 and 12 of E. Kreyszig, Advanced Engineering Mathematics.

Two good sources in German are:

Norbert Hungerbühler, "Einführung in die partiellen Differentialgleichungen"

G. Felder: Partielle Differentialgleichungen.

http://www.math.ethz.ch/u/felder/Teaching/PDG.

Prerequisites / notice
Analysis I and II, in particular, knowing how to solve ordinary differential equations is an important prerequisite.

402-0023-01L

Abstract
This course will cover the basic topics in Physics and will show/display/explain with a variety of experiments the most important physical effects. The course will address classical as well as modern physics, and the interplay between basic research and applications.

Objective

Content

Lecture notes
Manuskript und Übungsblätter

Literature
Hans J. Paus, Physik in Experimenten und Beispielen, Carl Hanser Verlag München Wien (als unternichtsbeigendes und ergänzendes Lehrbuch)

101-0203-01L

Abstract
The course teaches the basics of hydromechanics, relevant for civil and environmental engineers.

Objective
Familiarization with the basics of hydromechanics of steady state flows

Content
Properties of water, hydrostatics, stability of floating bodies, continuity, Euler equation of motion, Navier-Stokes equations, similarity, Bernoulli principle, momentum equation for finite volumes, potential flows, ideal fluids vs. real fluids, boundary layer, pipe flow, open channel flow, flow measurements, demonstration experiments in the lecture hall

Lecture notes
Script and collection of previous problems

Literature
Bohrlich, Technische Hydromechanik 1, Verlag Bauwesen, Berlin

151-0503-00L

Abstract
Kinematics, dynamics and oscillations: Motion of a single particle - Motion of systems of particles - 2D and 3D motion of rigid bodies

Objective
This course provides Bachelor students of mechanical engineering with fundamental knowledge of kinematics and dynamics of mechanical systems. By studying motion of a single particle, systems of particles and rigid bodies, we introduce essential concepts such as work and energy, equations of motion, and forces and torques. Further topics include stability of equilibria and vibrations. Examples presented in the lectures and weekly exercise lessons help students learn basic techniques that are necessary for advanced courses and work on engineering applications.

Content
1. Motion of a single particle || Kinematics: trajectory, velocity, acceleration, inertial frame, moving frames - Forces and torques. Active- and reaction forces. - Linear momentum principle, angular momentum principle, work-energy principle - Equations of motion;
2. Motion of systems of particles || Internal and external forces - Linear momentum principle, angular momentum principle, work-energy principle - Rigid body systems of particles; conservative systems
3. 3D motion of rigid bodies || Kinematics: angular velocity, velocity transport formula, instantaneous center of rotation - Linear momentum principle, angular momentum principle, work-energy principle - Parallel axis theorem. Angular momentum transport formula

Lecture notes
Typed course notes from the previous year

Literature
Please log in to moodle (https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php), search for "Dynamics", and join the course there. All exercises sheets, lecture materials etc. will be uploaded there.

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**Examination Block 2**

In place of the German course 851-0703-01 Grundzüge des Rechts für Bauwissenschaften students can take the French course 851-0709-00 Droit civil.
References to technical literature will be included in the course script. An additional list of literature will be given during the course.

4 credits

S. Zweidler

Type 3V+2U

Autography on plate girders, trusses, load introduction and redirection, steel concrete composite elements. Copies of presentations.

4G

Basics of dimensioning of plate girders, trusses and composite beams and columns (structural modeling, detailing and selection of material). Load introduction and redirection, detailing). Design, detailing and dimensioning of steel and steel concrete composite structures including roof and façades. Interaction of different building elements including bracing and global stability of steel structures.)

Understanding the response of elastic beam and frame structures

Ability to correctly apply the equilibrium conditions

Ability to determine elastic deformations

Ability to apply the force (flexibility) method for statically indeterminate structures

Content

Introduction

Reactions, internal forces and moments

Arches and cables

Trusses

Influence lines

Stresses and deformations

Principle of virtual work

Flexure and axial force, shear, torsion

Deflections, work equation

Statically indeterminate systems

Lecture notes


Handouts etc. available at:


Literature


Compulsory Courses 5. Semester

Examination Block 3

Number Title Type ECTS Hours Lecturers

101-0313-01L Geotechnical Engineering O 5 credits 4G A. Puzrin

Abstract

The course explores the fundamental principles of Geomechanics and Geotechnical Engineering, with the following objectives:

- Recognition of the basic consequences of the ground construction;
- Understanding of the important fundamental concepts of Soil mechanics and Geotechnical Engineering;
- Independent analysis of the basic geotechnical problems.

Objective

The course explores the fundamental principles of Geomechanics and Geotechnical Engineering, with the following objectives:

- Recognition of the basic consequences of the ground construction;
- Understanding of the important fundamental concepts of Soil mechanics and Geotechnical Engineering;
- Independent analysis of the basic geotechnical problems.

Content

Overview of stability problems; Bearing capacity of shallow and deep foundations; Soil-foundation interaction; Analysis and design of shallow and deep foundations; Earth pressure on retaining structures; Analysis and design of retaining walls; Excavations: dewatering, analysis and design; Soil improvement; Safety considerations.

Lecture notes

Examples

Exercises

Literature


101-0415-01L Railway Infrastructures (Transportation II) O 3 credits 2G U. A. Weidmann

Abstract

Fundamentals of railroad technology and interactions between track and vehicles, network development and infrastructure planning, planning of rail infrastructure, planning and design of railway stations, construction and dimensioning of tracks, approval and beginning service on complex infrastructure facilities, special issues of maintenance.

Objective

Teaches the basic principles of public transport network and topology design, geometrical design, dimensioning and construction as well as the maintenance of rail infrastructures. Teaches students to recognize the interactions between the infrastructure design and the production processes. Provides the background for Masters degree study.

Content

(1) Fundamentals: infrastructures of public transport systems; interaction between track and vehicles; passengers and goods as infrastructure users; management and financing of networks; railway standards and norms. (2) Infrastructure planning: Planning processes and decision levels in network development and infrastructure planning, planning of railway tracks and rail topologies; planning of the passenger parts of stations. (3) Infrastructure design: Fundamentals of the layout of a line; track geometry; switches and crossings; design of station platforms. (4) Construction of railway infrastructures: Assembly and evolution of the railway track; elements of the railway track; dimensioning of the track; track stability. (5) Approval and beginning service on complex infrastructure facilities: Definitions and limitations; fundamentals of the legal situation; test and approval processes; processes of putting railway systems into operation. (6) Maintenance of railway infrastructures: Fundamentals of infrastructure maintenance; kinds of deprivations; supervision methods; steps of infrastructure maintenance; estimation of maintenance need; methods to minimize maintenance costs.

Lecture notes

Course notes will be provided in German. Slides are made available some days before each lecture.

Literature

References to technical literature will be included in the course script. An additional list of literature will be given during the course.
Hydrology

An introduction to system development, analysis and optimization, with focus on linear programming, networks, decision theory, economic analysis, and managing water resources.

Know the main features of engineering hydrology. Apply methods to estimate hydrological variables for dimensioning hydraulic structures and managing water resources.

Der hydrologische Kreislauf: globale Wasserressourcen, Wasserbilanz, räumliche und zeitliche Dimension der hydrologischen Prozesse.


Interzeption: Messung und Schätzung.

Evaporation und Evapotranspiration: Prozesse, Messung und Schätzung, potentielle und effektive Evapotranspiration, Energiebilanzmethode, empirische Methode.

Infiltration: Messung, Horton-Gleichung, empirische und konzeptionelle Methoden, F-index und Prozentielle Methode, SCS-CN Methode.


Schnee und Eis: Schneeeigenschaften und -messungen Schätzung des Schneeschmelzprozesses durch die Energiebilanzmethode, Abfluss aus Schneeschmelze, Temperatur-Index- und Grad-Tag-Verfahren.


Hochwasserabschätzung: empirische Formeln, Hochwasserfrequenzanalyse, Regionalisierungstechniken, indirekte Hochwasserabschätzung mit N-A Modellen, Rationaler Methode.

Lecture notes

Ein internes Skript steht zur Verfügung ( kostenpflichtig, nur Herstellungskosten)

Die Kopie der Folien zur Vorlesung können auf den Webseiten der Professur für Hydrologie und Wasserwirtschaft herunterladen werden


Prerequisites / notice

Vorbereitende zu Hydrologie I sind die Vorlesungen in Statistik. Der Inhalt, der um ein Teil der Übungen zu behandeln um ein Teil der Vorlesungen zu verstehen notwendig ist, kann zusammengefasst werden, wie hintereinander es beschrieben wird:

- Elementare Datenverarbeitung: Hydrologische Messungen und Daten, Datenreduzierung (grafische Darstellungen und numerische Kenngrössen).

Examination Block 4

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0125-00L</td>
<td>Structural Concrete I</td>
<td>O</td>
<td>5</td>
<td>4</td>
<td>W. Kaufmann</td>
</tr>
</tbody>
</table>

Abstract

Contents: Introduction, historical development of structural concrete, materials and material behaviour (cement, concrete, reinforcing steel, prestressing steel), linear members (axial force, flexure and axial force, compression members and columns, shear, bending and shear, torsion and combined actions), strut-and-tie models and simple stress fields, detailing, basic aspects of membrane elements.

Objective

- Knowing the materials concrete and reinforcing steel and understanding their interaction;
- Understanding the response of typical structural members;
- Knowing elementary models and ability to apply them to practical problems;
- Ability to correctly dimension and detail simple structures.

Content

- Introduction, historical development of structural concrete, materials and material behaviour (cement, concrete, reinforcing steel, prestressing steel), linear members (axial force, flexure and axial force, compression members and columns, shear, bending and shear, torsion and combined actions), strut-and-tie models and simple stress fields, detailing.

Lecture notes

Introduction into the basic and practical knowledge of important building materials and testing methods. The project work conceptual design conveys a first insight into the holistic approach to cope with typical tasks of civil engineering and introduces professional techniques of civil engineering to students. A further aim is to consolidate the knowledge gained so far in bachelor courses, to link different domains and to fill gaps with respect to working techniques. The students analyse the inventory, formulate design requirements and boundary conditions, elaborate approaches and proposals for solutions, dimension some exemplary structural elements, practise detailing and document their work by different media.

Methodology:
Excursion with mission, lectures, autonomous work, poster session, role playing, workshop, exemplary plenary review.

Deliverables:
Poster, sketches, service criteria agreement and basis of design, static calculations, plans, models, technical report.

Lecture notes:
Lecture notes, partially as download

http://www.vogel.ibk.ethz.ch/studium/downloads.html

Literature:
Codes SIA 260, 261, 400

Materials III
Introduction into the basic and practical knowledge of important building materials and testing methods.

- Introduction of material testing equipment, with various examples of experiments on metals (tensile behaviour, hardness, bending and impact loading).
- Theoretical background and practical aspects of concrete technology: mixture design, casting and setting; determination of mechanical properties.
- Properties of bricks and mortar: individual materials and the composite brickwork. Parameters like strength, Youngs modulus, water absorption and thermal conductivity are determined.
- Understanding the characteristic properties of wood: anisotropy, hygroscopic behaviour, shrinkage and swelling, and effect of size on strength. Introduction to test-methods for wood and wood-products.
- Introduction into the basics of scanning electron microscopy: practical exercises with the Environmental Scanning Electron Microscope (ESEM).
- Introduction to fundamentals of Finite Element Methods and their application in examples.
- Introduction to durability of building materials and building structures: assessment of potentials for detecting and locating corrosion of steel reinforcement in concrete.

Prerequisites:
- Theory of Structures I and “Theory of Structures II”.

Additional Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0007-01L</td>
<td>Project Work Conceptual Design</td>
<td>O</td>
<td>3</td>
<td>3S</td>
<td>T. Vogel</td>
</tr>
</tbody>
</table>

Abstract
A structure to be designed serves as a mean to practice the holistic approach of conceptual design by working in parallel and iteratively on different levels of detailing. Both, requirements and scope of action, are identified by the students and serve as basis for a solution. The task group organizes itself to solve complex tasks.

Objective
The project work conceptual design conveys a first insight into the holistic approach to cope with typical tasks of civil engineering and introduces professional techniques of civil engineering to students.

Content
Topics:
- Analysis of the inventory, layout of posters, basics of graphic representation, service criteria agreement and basis of design, structural design and modelling, preliminary dimensioning, technical drawing and model making, materialisation and detailing, literature research and scientific referencing.

Bachelor’s Thesis

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0066-10L</td>
<td>Bachelor’s Thesis Only for Civil Engineering BSc, Programme Regulations 2014</td>
<td>O</td>
<td>8</td>
<td>16D</td>
<td>Lecturers</td>
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</tbody>
</table>

Bachelor Studies (Programme Regulations 2010)

Übrie obligatorische Fächer

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>

Wird zum letzten Mal im HS16 angeboten.

Abstract
Introduction into the basic and practical knowledge of important building materials and testing methods.

Objective
Introduction into the basic and practical knowledge of important building materials and testing methods.

Content
- Introduction of material testing equipment, with various examples of experiments on metals (tensile behaviour, hardness, bending and impact loading).
- Theoretical background and practical aspects of concrete technology: mixture design, casting and setting; determination of mechanical properties.
- Properties of bricks and mortar: individual materials and the composite brickwork. Parameters like strength, Youngs modulus, water absorption and thermal conductivity are determined.
- Understanding the characteristic properties of wood: anisotropy, hygroscopic behaviour, shrinkage and swelling, and effect of size on strength. Introduction to test-methods for wood and wood-products.
- Introduction into the basics of scanning electron microscopy: practical exercises with the Environmental Scanning Electron Microscope (ESEM).
- Introduction to fundamentals of Finite Element Methods and their application in examples.
- Introduction to durability of building materials and building structures: assessment of potentials for detecting and locating corrosion of steel reinforcement in concrete.

Bachelor’s Thesis

For each topic a script will be provided, that can be downloaded under www.ifb.ethz.ch/education
The Bachelor Programme concludes with the Bachelor Thesis. This project is supervised by a professor. Writing up the Bachelor Thesis encourages students to show independence and to produce structured work.

Objective
Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

Content
The contents base upon the fundamentals of the Bachelor Programme. Students can choose from different subjects and tasks. The thesis consists of both a written report and an oral presentation.

Electives
The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Electives Courses ETH Zurich
Course Catalogue of ETH Zurich

GESS Science in Perspective
Recommended GESS Science in Perspective (Type B) for D-BAUG.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Civil Engineering Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>E-</th>
<th>Z</th>
<th>Dr</th>
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<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
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<td>W</td>
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Key for Hours

<table>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Civil Engineering Master

1. Semester

Seminar Work

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0007-00L</td>
<td>Conceptual Design</td>
<td>O</td>
<td>4</td>
<td>3S</td>
<td>T. Vogel, H. Figi, H. Schnetzer</td>
</tr>
</tbody>
</table>

Abstract
Procurement of consistent procedures to solve typical problems of civil engineering. Consolidation of the knowledge of the bachelor courses; integration of bachelors of other universities.
Practice of the holistic approach of conceptual design, parallel and iterative operations on varying levels of detailing. Integration of different fields of knowledge and experiences.

Objective
Procurement of consistent procedures to solve typical problems of civil engineering. Consolidation of the knowledge of the bachelor courses; integration of bachelors of other universities.
Practice of the holistic approach of conceptual design, parallel and iterative operations on varying levels of detailing. Integration of different fields of knowledge and experiences.

Content
Basic tools:
- Literature research, quotations
- Technical report and presentations
- Basics of graphical representation

Elements of the design process:
- Service criteria and respective agreement
- Design requirements and design boundary conditions
- Design alternatives
- Preliminary dimensioning
- Cost effectiveness
- Optimization
- Detailing

Exemplary consolidations:
- Geotechnical basics of retaining walls
- Conceptual design and shaping of retaining walls
- Drainage of structures
- Case study conceptual bridge design

Implementation with a planning tutorial:
- Presentation of the objects
- Survey and inventory
- Design options
- Intermediate review
- Final presentation

Lecture notes
Lecture notes, partially as download
http://www.vogel.ibk.ethz.ch/studium/downloads.html

Literature
Normen

Weiterführende Literatur

Major Courses

Major in Construction and Maintenance Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0579-00L</td>
<td>Infrastructure Maintenance Processes</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>B. T. Adey</td>
</tr>
</tbody>
</table>

Abstract
This course provides an introduction to the tools that can be used to evaluate infrastructure. In particular tools:
- to measure the level of service being obtained from infrastructure,
- to predict slow changes in infrastructure over time, and
- to predict fast changes in infrastructure over time.

Objective
to equip students with tools to be used to evaluate infrastructure and the level of service being provided from infrastructure

Content
Introduction
- Levels of service
- Reliability of infrastructure
- Availability and maintainability of infrastructure
- Mechanistic-empirical models
- Regression analysis
- Event trees
- Fault trees
- Markov chains
- Neural networks
- Bayesian networks

Conclusion

Lecture notes
All necessary materials (e.g. transparencies and hand-outs) will be distributed before class.

Literature
Appropriate reading material will be assigned when necessary.

Lecture notes will be distributed electronically during the course.

Prerequisites / notice

Fundamentals of chemistry, physics and thermodynamics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

606-0427-00L  Design and Building Process MBS

Objective

"Design and Building Process MBS" is a brief manual for prospective architects and engineers covering the competencies and the responsibilities of involved parties through the design and building process. Lectures on twelve compact aspects gaining importance in an increasingly specialised, complex and international surrounding.

Content

"Design and Building Process MBS" is a brief manual for prospective architects and engineers covering the competencies and the responsibilities of involved parties through the design and building process. Twelve compact aspects regarding the establish building culture are gaining importance in an increasingly specialised, complex and international surrounding. Lectures on the topics of profession, service model, organisation, project, design quality, coordination, costing, tendering and construction management, contracts and agreements, life cycle, real estate market, and getting started will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship. The course introduces the key figures, depicts the criteria of the project and highlights the provided services of the consultants. In addition to discussing the basics, the terminology and the tendencies, the lecture units will refer to the studios as well as the practice: Teaching-based case studies will compliment and deepen the understanding of the twelve selected aspects. The course is presented as a moderated seminar to allow students the opportunity for individual input: active collaboration between the students and their tutor therefore required.

101-0427-01L  System and Network Planning

Objective

Public transports in the context of the transport systems; customer needs in the transport market; service planning processes for regular public transport services; long distance, regional and urban public transport service strategies; access to public transport and the last mile

Content

Students will develop a basic knowledge of all stages of the public transport planning process from market demand to service planning; they will understand the most relevant planning methods and will be able to use them

License notes

A script in German will be provided for the course. The slides are made available.

Prerequisites / notice

References to technical literature will be included in the course script. An additional list of literature will be given during the course.

101-0520-00L  Project Management: Project Execution to Closeout

Objective

The course will give Engineering students a comprehensive overview and enduring understanding of the techniques, processes, tool and terminology to manage the Project Triangle (time, cost Quality) and to organize, analyze, control and report a complex project from start of Project Execution to Project Completion. Responsibilities will be detailed in each phase of the execution.

A student after completing the course will have the understanding of the Project Management duties, responsibilities, actions and decisions to be done during the Execution phase of a complex project.
### 101-0521-00L Project Management for Construction Projects

| W+ | 3 credits | 2S | B. García de Soto Lastra |

**Abstract**
This course is designed to lay down the foundation of the different concepts, techniques, and tools for successful project management of construction projects.

**Objective**
The goal is that at the end of this course students should have a good understanding of the different project management knowledge areas, the phases required for successful project management, and the role of a project manager. To demonstrate this, students will work in groups in different case studies to apply the concepts, tools and techniques presented in the class.

**Content**
The main content of the course is summarized in the following topics:
- Project and organization structures
- Project scheduling
- Resource management
- Project estimating
- Project financing
- Risk management
- Interpersonal skills

**Lecture notes**
The slides for the class will be available for download from Moodle at least one day before each class. Copies of all necessary documents will be distributed at appropriate times.

**Literature**
Relevant readings will be recommended throughout the course (and made available to the students via Moodle).

**Prerequisites / notice**
Prerequisite for this course is course Project Management: Pre-Tender to Contract Execution number 101-0517-01 G, unless otherwise approved by the lecturer.

### 101-0522-00L Introduction to Construction Information Management & Modelling

| W+ | 3 credits | 2G | B. García de Soto Lastra |

**Abstract**
This course will provide both a theoretical background and a pragmatic project work (case studies) on current trends and developments of information modeling and management in the construction industry around the world and in Switzerland. The course will include external lecturers from engineering and construction companies in Switzerland.

**Objective**
Students enrolled in this course are expected to become familiar with current information modeling and management technologies and their applications to the construction industry, and to get a good understanding of new project delivery systems and technologies for integrated practice.

**Content**
The content of the course is summarized in the following topics:
- Introduction to information modeling and management technologies
- Integrated Project Delivery (IPD) (vs. traditional delivery methods)
- Information model execution plan
- Information modeling tools and parametric modeling
- Interoperability
- Standards and foundations
- Implications for engineers and the construction industry
- Implications for owners and facility managers
- Information Modeling and Prefabrication
- Construction Analysis and Planning (4D modeling)
- Quantity Takeoff and Cost Estimating (5D modeling)

**Lecture notes**
The slides for the class will be available for download from Moodle at least one day before each class. Copies of all necessary documents will be distributed at appropriate times.

**Literature**
Relevant readings will be recommended throughout the course and made available to the students via Moodle.

**Prerequisites / notice**
There are no pre-requisites to enroll in this course.

Note: the use of special software (e.g. Revit, ArchiCAD) or simulation software (e.g., Bentley ConstrucSim, Navisworks, Solibri Model Checker, etc.) is beyond the scope of this course.

### 101-0509-00L Infrastructure Management 1: Process

| W+ | 3 credits | 2G | B. T. Adey |

**Abstract**
The course provides an introduction to the steps included in the infrastructure management process. The lectures are given by a mixture of external people in German and internal people in English.

**Objective**
Upon completion of the course, students will
- understand the steps required to manage infrastructure effectively,
- understand the complexity of these steps, and
- have an overview of the tools that they can use in each of the steps.

**Content**
- The infrastructure management process and guidelines
- Knowing the infrastructure - Dealing with data
- Establishing goals and constraints
- Establishing organization structure and processes
- Making predictions
- Selecting strategies
- Developing programs
- Planning interventions
- Conducting impact analysis
- Reviewing the process

**Lecture notes**
Appropriate reading / and study material will be handed out during the course. Transparencies will be handed out at the beginning of each class.

**Literature**
Appropriate literature will be handed out when required.

**Prerequisites / notice**
The courses will be given half in English and half in German. Students should have a minimum of level B2 in both to register for the course.
### Major in Geotechnical Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0317-00L</td>
<td>Tunnelling I</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>G. Anagnostou, E. Pimentel</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Basic aspects of design and analysis of underground structures. Conventional tunnel construction methods. Auxiliary measures (ground improvement and drainage, forepoling, face reinforcement). Numerical analysis methods.</td>
<td></td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Basic aspects of design and analysis of underground structures. Conventional tunnel construction methods. Auxiliary measures (ground improvement and drainage, forepoling, face reinforcement). Numerical analysis methods.</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Numerical analysis methods in tunnelling. Conventional excavation methods (full face, top heading and bench, side drift method, ...). Auxiliary measures: - Injections - Jet grouting - Ground freezing - Drainage - Forepoling - Face reinforcement</td>
<td></td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Autographieblätter</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Literature</strong></td>
<td><a href="http://geotip.igt.ethz.ch/">http://geotip.igt.ethz.ch/</a></td>
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</table>

### Theoretical and Experimental Soil Mechanics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0357-00L</td>
<td>Theoretical and Experimental Soil Mechanics</td>
<td>W+</td>
<td>6</td>
<td>4G</td>
<td>I. Anastasopoulos, R. Herzog</td>
</tr>
<tr>
<td><strong>Prerequisites:</strong></td>
<td>Mechanics I, II and III.</td>
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</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The number of participants is limited to 60 due to the existing laboratory equipment! Students with major in Geotechnical Engineering have priority. Registrations will be accepted in the order they are received.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Overview of soil behaviour Extent knowledge of theoretical approaches that can be used to describe soil behaviour to enable students to carry out more advanced geotechnical design and to plan the appropriate laboratory tests to obtain relevant parameters for coupled plasticity models of soil behaviour. A further goal is to give students the wherewithal to be able to select an appropriate constitutive model and set up insitu stress conditions in preparation for subsequent numerical modelling (e.g. with finite elements).</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Overview of soil behaviour Discussion of general gaps between basic theory and soil response Stress paths in practice &amp; in laboratory tests</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Printed script with web support Exercises</td>
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<tr>
<td><strong>Literature</strong></td>
<td><a href="http://geotip.igt.ethz.ch/">http://geotip.igt.ethz.ch/</a></td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Lectures will be conducted as Problem Based Learning within the framework of a case history Virtual laboratory in support of 'hands-on' experience of selected laboratory tests</td>
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<tr>
<td><strong>Pre-requisites:</strong></td>
<td>Basic knowledge in soil mechanics as well as knowledge of advanced mechanics Laboratory equipment will be available for 60 students. First priority goes to those registered for the geotechnics specialty in the Masters, 2nd year students then first year students, doctoral students qualifying officially for their PhD status and then 'first come, first served'.</td>
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</table>

### Design and Construction in Geotechnical Engineering

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<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0307-00L</td>
<td>Design and Construction in Geotechnical Engineering</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>I. Anastasopoulos, A. Marin, A. Zafeirakos</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This lecture deals with the practical application of the knowledge gained in the fundamental lectures from the Bachelor degree. The basics of planning and design of geotechnical structures will be taught for the main topics geotechnical engineers are faced to in practice.</td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Transfer of the fundamental knowledge taught in the Bachelor degree to practical application. Ability to plan and design geotechnical structures based on the state of the art.</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Introduction to Swisscode SIA Foundations and settlements Pile foundations Excavations Slopes Soil nailing Reinforced geosystems Ground improvement River levees</td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Script in the form of chapters and powerpoint overheads with web support (<a href="http://geotip.igt.ethz.ch">http://geotip.igt.ethz.ch</a>) Exercises</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Relevant literature will be stated during the lectures</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Pre-condition: Successful examinations (pass) in the geotechnical studies (soil mechanics and ground engineering, each 5 credits) in the Bachelor degree of Civil Engineering (ETH), or equivalent for new students. The lecture contains at least one presentation from practice</td>
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</table>

### Forensic Geotechnical Engineering

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<tr>
<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0369-00L</td>
<td>Forensic Geotechnical Engineering</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Puzrin</td>
</tr>
<tr>
<td><strong>Prerequisites:</strong></td>
<td>Successful participation in &quot;Geotechnical Engineering&quot; (101-0315-00L) or an equivalent course.</td>
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<tr>
<td><strong>Abstract</strong></td>
<td>In this course selected famous geotechnical failures are investigated with the following purpose: (a) to deepen understanding of the geotechnical risks and possible solutions; (b) to practice design and analysis methods; (c) to learn the techniques for investigation of failures; (d) to learn the techniques for mitigation of the failure damage.</td>
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</tbody>
</table>

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 164 of 1571
Objective

In this course selected famous geotechnical failures are investigated with the following purpose: (a) to deepen understanding of the geotechnical risks and possible solutions; (b) to practice design and analysis methods; (c) to learn the techniques for investigation of failures; (d) to learn the techniques for mitigation of the failure damage.

Content

Failure due to the loading history
Failure due to the creeping landslides
Failure due to excessive settlements
Failure due to tunneling
Failure due to tunnelling
Bearing capacity failure
Excavation failure

Lecture notes

Lecture notes
Exercises

Literature


Prerequisites / notice

The course is given in the first MSc semester.
Prerequisite: Basic knowledge in Geotechnical Engineering (Course content of "Grundbau" or similar lecture).

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## Major in Structural Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0117-00L</td>
<td>Structural Analysis III</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>D. Heinemann, S. Zweidier</td>
</tr>
<tr>
<td>Abstract</td>
<td>Enhanced understanding of the load-deformation response of beam and frame structures. Systematic treatment of elementary and combined load carrying mechanisms of elastic beams, cables, arches and rings.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Enhanced understanding of the load-deformation response of beam and frame structures. Systematic treatment of elementary and combined load carrying mechanisms of elastic beams, cables, arches and rings.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Axially loaded members, shear deformation of girders, torsion, beams, cables, arches and rings, shear walls and frames, combined cable and flexural action.</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Lecture notes</td>
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</tr>
</tbody>
</table>

| 101-0127-00L | Structural Concrete III             | O    | 3 credits | 2G    | W. Kaufmann      |
| Abstract     | This course supplements the courses Structural Concrete I and II regarding the analysis and dimensioning of reinforced and prestressed concrete structures. It focuses on lower bound and upper bound limit analysis methods for girders, discs and shells, particularly regarding their applicability to the safety assessment of existing structures. |
| Objective    | Enhancement of the understanding of the load-deformation reponse of reinforced and prestressed concrete: refined knowledge of models and ability to apply them to general problems, particularly regarding the structural safety assessment of existing structures; awareness of the limits of applicability of limit analysis methods and ability to check their applicability. |
| Content      | Fundamentals (structural analysis, theorems of limit analysis, applicability of limit analysis methods); shear walls and girders (stress fields and truss models, failure mechanisms, deformation capacity, membrane elements with yield conditions and load-deformation behaviour); slabs (equilibrium solutions, yield conditions, failure mechanisms, shear in slabs); prestressed concrete for plate and shell structures; long term effects; complements (fire, watertight concrete structures). |

| 101-0137-00L | Steel Structures III               | O    | 3 credits | 2G    | M. Fontana       |
| Abstract     | Enhance theoretical considerations and detailing of structural steel design including aspects of economy and erection. E.g. Cranes, composite construction (compression and bending, continuous girders, partial connection, serviceability), fire design, stability of frames and buckling of plates with stiffeners, cold rolled sections, corrosion protection, price calculation and quality control. |
| Objective    | Enhance theoretical considerations and detailing of structural steel design including aspects of economy and erection. |
| Content      | Constructive design of cranes, composite construction (compression and bending, continuous girders, partial connection, serviceability), fire design, stability of frames and buckling of plates with stiffeners, cold rolled sections, corrosion protection, price calculation and quality control. |
| Lecture notes| Autography                          |
| Literature   | - Stahlbauhandbuch 1 und 2, Stahlbau-Verlags-GmbH, Köln |
|             | - Stahlbaualkalender 2000, Ernst + Sohn, Berlin, 1999 |
| Prerequisites / notice | Prerequisites: Steel Structures I and II |

| 101-0187-00L | Structural Reliability and Risk Analysis | W    | 3 credits | 2G    | B. Sudet       |
| Abstract     | Structural reliability aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing and environmental conditions. Risk analysis combines this information with the consequences of failure in view of optimal decision making. The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment. |
| Objective    | The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field. |
| Lecture notes|                                      |

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Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro-codes usually provide a framework that guarantees safety and reliability. However the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FORM) and the first order reliability method (FOM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented.

The course also includes a tutorial using the UQLab software dedicated to real world structural reliability analysis.

Lecture notes
Slides of the lectures are available online every week. A printed version of the full set of slides is proposed to the students at the beginning of the semester.

Literature
S. Marelli, R. Schöbi, B. Sudret, UQLab user manual - Structural reliability (rare events estimation), Report UQLab-v0.92-107.

Prerequisites / notice
Basic course on probability theory and statistics

<table>
<thead>
<tr>
<th>Subject</th>
<th>Code</th>
<th>Credits</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Dynamics and Vibration Problems</td>
<td>101-0157-01L</td>
<td>3</td>
<td>B. Stojadinovic</td>
</tr>
<tr>
<td>Vibration Problems in Structures: Practical Guidelines, Hugo Bachmann et al., Birkhäuser, Basel,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>101-0177-00L</td>
<td>Moisture transport and related degradation processes in building and civil engineering materials and structures; concepts of poromechanics and multiscale analysis; analysis of damage cases.</td>
<td>3</td>
<td>J. Carmeliet, T. Defraeye</td>
</tr>
<tr>
<td>Building Physics: Moisture and Durability</td>
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101-0167-01L Fibre Composite Materials in Structural Engineering

Abstract
1) Lamina and Laminate Theory
2) FRP Manufacturing and Testing Methods
3) Design and Application of Externally Bonded Reinforcement to Concrete, Timber, Masonry, and metallic Structures
4) FRP Reinforced Concrete, All FRP Structures
5) Measurement Techniques and Structural Health Monitoring

Objective
At the end of the course, you shall be able to

1) Design advanced FRP composites for your structures,
2) To consult owners and clients with necessary testing and SHM techniques for FRP structures,
3) Continue your education as a PhD student in this field.

Content
Fibre Reinforced Polymer (FRP) composites are increasingly being used in civil infrastructure applications, such as reinforcing rods, tendons and FRP Profiles as well as wraps for seismic upgrading of columns and repair of deteriorated structures. The objective of this course is on one hand to provide new generation of engineering students with an overall awareness of the application and design of FRP reinforcing materials for internal and external strengthening (repair) of reinforced concrete structures. The FRP strengthening of other structures such as metallic, timber and masonry will also be shortly discussed. On the other hand the course will provide guidance to students seeking additional information on the topic. Many practical cases will be presented analysed and discussed. An ongoing structural health monitoring of these new materials is necessary to ensure that the structures are performing as planned, and that the safety and integrity of structures is not compromised. The course outlines some of the primary considerations to keep in mind when designing and utilizing structural health monitoring technologies. During the course, students will have the opportunity to design FRP strengthened concrete beams, apply the FRP by themselves, and finally test their samples up to failure.

Lecture notes
1) Power Point Printouts
2) Handouts

Literature
2) fib bulletin 14, Externally Bonded FRP Reinforcement for RC Structures, 2001

101-0190-06L Topics on Signal Processing and Identification

Abstract
In this course some fundamental topics on digital signal processing will be reviewed. This includes an introduction to digital signals in time, frequency and z-domain, as well as sampling theory and digital filter design. We will then discuss the state space model of dynamic systems and introduce methods of identification of such systems, with an emphasis on using data from mobile sensors.

Objective
The students will be able to analyse digital signals and systems in time-, z-, and frequency domains, and create, implement, and identify digital systems. The examples and sample data are measured from civil structures.

101-0637-01L Wood and Wood Composites

Abstract

Objective

Content
Characteristic properties of wood as a anisotropic and porous material and their consideration in structural timber design. History, ecology, structure of timber, drying, material properties, influence of moisture and creep, grading, Durability. Material properties and field of applications of solid timber, glued laminated timber and wood composites. Fire safety and fire design.

Lecture notes
Power Point slides, Further literature.

Literature

Prerequisites / notice
Die Vorlesung ist mit einer halbtägigen Excursion verbunden. Voraussetzungen: Grundkenntnisse der Baustoffkunde

Voraussetzungen: Grundkenntnisse der Baustoffkunde

Autumn Semester 2016
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students develop their own models.

- Knowledge of methods and algorithms commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning

The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such planning problems are the estimation of traffic volumes, prediction of estimated utilization of new public transport lines, and evaluation of effects (e.g. change in emissions of a city) triggered by building new infrastructure and changes to operational regulations.

To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

The slides of the lecture are provided electronically.

Verkehr III - Road Transport Systems 6th Sem. BSc (101-0415-00L)

Special permission from the instructor can be requested if the student has not taken Verkehr III.
The course explains main principles of air transport in general and elaborates on simple interdisciplinary topics. Lecturers Slides are provided prior to each class. Agent Based Modeling in Transportation (Additional Knowledge of hydraulic structures and their function within a hydraulic scheme. Skills for the layout and design of hydraulic structures with regard to economy and safety). Objective Understand and explain basics, principles and concepts in the broader air transport industry. Lay the foundation of working in or with the air transport industry. Content Weekly: 1h independent preparation; 2h lectures and 1 h training with an expert in the respective field. Lecture notes Further information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development. Literature We will also use English papers.

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<tr>
<th>Number</th>
<th>Title</th>
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<td>101-0499-00L</td>
<td>Basics in Air Transport</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>P. Wild</td>
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<tr>
<td>101-0491-01L</td>
<td>Agent Based Modeling in Transportation (Additional JAVA Exercises)</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>F. Ciarl, M. Balac</td>
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<tr>
<td>101-0247-01L</td>
<td>Hydraulic structures II</td>
<td>O</td>
<td>6 credits</td>
<td>4G</td>
<td>R. Boes</td>
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</table>
Prerequisites / notice

Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).

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<tr>
<th>Course Code</th>
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<td>101-0267-01L</td>
<td>Numerical Hydraulics</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Holzner</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>In the course Numerical Hydraulics the basics of numerical modelling of flows are presented.</td>
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<td>The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.</td>
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<td><strong>Content</strong></td>
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<td>The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated. All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.</td>
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<td><strong>Lecture notes</strong></td>
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<td></td>
<td>Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.</td>
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<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. Burlando, S. Fatichi</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.</td>
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<td>Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.</td>
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<td></td>
<td><strong>Content</strong></td>
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<td><strong>Lecture notes</strong></td>
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<td>Parts of the script for &quot;Hydrology I&quot; are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.</td>
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<td>102-0455-01L</td>
<td>Groundwater I</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Willmann</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>The course provides an introduction into quantitavie analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.</td>
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<td>b) Students are able to formulate simple practical flow and transport problems.</td>
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<td>c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.</td>
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<td>d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.</td>
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<td><strong>Content</strong></td>
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<td></td>
<td>Introduction, aquifers, groundwater use, sustainability, porosity.</td>
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<td>Properties of porous media.</td>
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<td>Exercises: Groundwater use, porosity, grain size analysis.</td>
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<td>Flow properties, Darcy's law, filter.</td>
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<td>Flow equations, stream function.</td>
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<td>Analytical solutions, confined aquifers, steady-state flow.</td>
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<td>Use of superposition principles, transient flow, freee surface flow.</td>
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<td>Exercises: Analytical solutions to flow problems.</td>
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<td>Finite difference solutions to flow problems I.</td>
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<td>Exercises: Analytical solutions to flow problems.</td>
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<td>Finite difference solutions to flow problems II.</td>
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<td>Exercises: Finite difference formulations to flow problems.</td>
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<td>Transport processes.</td>
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<td>Exercises: Computer workshop using PMWIN.</td>
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<td>Analytical solutions to transport problems I.</td>
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<td>Exercises: Computer workshop using PMWIN.</td>
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<td>Path lines, groundwater protection.</td>
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<td>Exercises: Analytical solutions to transport problems.</td>
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<td>Groundwater remediation, groundwater management.</td>
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<td>Exercises: Groundwater remediation.</td>
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<td><strong>Lecture notes</strong></td>
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<td>Folien auf Internet unter <a href="http://www.ihw.ethz.ch/GWH/education/index">www.ihw.ethz.ch/GWH/education/index</a></td>
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<td>Altes Skript auf Internet <a href="http://www.ihw.ethz.ch/GWH/education/index">www.ihw.ethz.ch/GWH/education/index</a></td>
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<td>Didaktische Software auf Internet unter <a href="http://www.ihw.ethz.ch/GWH/education/index">www.ihw.ethz.ch/GWH/education/index</a></td>
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**101-0258-00L River Engineering**

**Abstract**
The lecture addresses the fundamentals to quantitatively describe the flow of water, the transport of sediments and morphological changes like erosion or deposition in watercourses. Further addressed are the design and dimensioning of river engineering works to create and ensure sufficient capacity, channel stability as well as to ensure the ecological functions of the watercourse.

**Objective**
The students shall - be able to describe the relationship between discharge, sediment transport and channel evolution quantitatively
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration
- be capable to design and dimension river engineering works needed to influence the processes in watercourses

**Content**
The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armorning and the principles of incipient motion, initiation of erosion as well as sediment transport (bed load, suspended load) are treated.

In the second part of the lecture, the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formation and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of channel stability, bed forms, river morphology and scour.

The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics focussed on are the stabilization of banks and of the longitudinal profile of rivers.

**Lecture notes**
Lecture notes "River Engineering" (in German, 470 pages, including list of references)

**Literature**
The lecture notes contain a comprehensive list of references for further reading.

**Prerequisites / notice**
Strongly recommended lectures:
- Hydrology (102-0293-AAL), Hydraulics I (101-0203-01L) and Hydraulic Engineering (101-0206-00L)

A practical exercise (voluntary, unmarked) is offered to deepen the learned subjects.

This exercise bases on field data, which are partly collected by the students on a river in nature. Besides the collection of fundamentals and field data, the exercise comprehends the calculation of the stage-discharge relationship, of the critical discharges for initiation of bed load transport and bed erosion and of the annual sediment load in a given river reach.

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**Major in Materials and Mechanics**

**Number**

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<tr>
<th>Number</th>
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<td>101-0517-00L</td>
<td>Materials IV</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>H. J. Herrmann, I. Burgert, R. J. Flatt, F. Wittel</td>
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</tbody>
</table>

**Abstract**
This lecture is focused on current issues of materials research from various fields. It provides an overview on various directions of research on civil engineering materials and is intended to simplify the further choice of courses.

**Objective**
Based on the bachelor courses Materials I-III, current, fundamental, and important issues of specific building materials are addressed. Next to aspects of material production, usage and properties, their interaction with the environment e.g. by durability and environmental impact are addressed. This course is intended to simplify the further selection of courses.

**Content**
The lecture is segmented into 13 important problems, namely:

1. Materials, Structures, and Sustainability
2. Granular matter (DEM)
3. Fracture mechanics and size effects in concrete
4. Cyclic failure of asphalt (Fatigue)
5. Mechanics and failure of fiber reinforced materials
6. Wood: from the tree to the beam (multi scale approaches)
7. Transport and degradation in porous building materials
8. Rheology
9. Plasticity
10. Foam (e.g. polymers)
11. Gluing and coating (surfaces)
12. Asbestos, nano particles and hazardous substances
13. Biomimetics in Constructions

**Lecture notes**
download from www.ifb.ethz.ch/education

**Literature**
download from www.ifb.ethz.ch/education

**Prerequisites / notice**
The lecture will be given in english.

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**402-0809-01L Introduction to Computational Physics (for Civil Engineers)**

**Abstract**
This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell’s equation), Monte Carlo simulations, percolation, phase transitions.

**Content**

**Prerequisites / notice**
Lecture and exercise lessons in english

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**101-0677-00L Concrete Technology**

**Abstract**
Opportunities and limitations of concrete technology, Commodities and leading edge specialties.

**Objective**
Advanced education in concrete technology for civil engineers who are designing, specifying and executing concrete structures.
Based on the lecture 'Werkstoffe I' students receive deep concrete technology training. A comprehensive knowledge of the most important properties of conventional concrete and the current areas of research in concrete technology will be presented. The course covers various topics.

The content of the course is:
- concrete components
- concrete properties
- concrete mix design
- production, transport, casting
- demoulding, curing and additional protective measures
- durability
- standards
- high performance concretes
1. high strength and ultra high strength concrete
2. fiber reinforced concrete
3. self compacting concrete
4. shotcrete
5. light weight concrete
6. low shrinkage concrete
7. low heat concrete for mass structures
8. frost and wear resistant concrete
9. concrete for low and high ambient temperatures

Lecture notes
Slides provided for download.

101-0177-00L  Building Physics: Moisture and Durability  W  3 credits  2G  J. Carmeliet, T. Defraeye

Abstract
Moisture transport and related degradation processes in building and civil engineering materials and structures; concepts of poromechanics and multiscale analysis; analysis of damage cases.

Objective
- Basic knowledge of moisture transport and related degradation processes in building and civil engineering materials and structures
- Introduction to concepts of poromechanics and multiscale analysis
- Application of knowledge by the analysis of damage cases

Content
1. Introduction
   Moisture damage: problem statement
   Durability

2. Moisture Transport
   Description of moisture transport
   Determination of moisture transport properties
   Hysteresis
   Transport in cracked materials
   Damage and moisture transport in cracked media

3. Poromechanics
   Moisture and mechanics: poro-elasticity
   Poro-elasticity and salt crystallisation
   Poro-elasticity and damage
   Case studies

4. Multiscale analysis
   Problem statement
   Multiscale transport model
   Multiscale coupled transport - damage model

101-0648-00L  Metallic Materials and Corrosion  W  3 credits  2G  B. Elsener

Abstract
Metals in civil engineering (steels, high strength steel, Al-alloys, stainless steels). Mechanisms to improve the mechanical properties, plastic deformation (dislocations), mechanical tests. Corrosion, stress corrosion. The goal is the understanding of the relation between chemical composition, microstructure and mechanical properties and durability (corrosion) of metallic materials. Case studies.

Objective
Knowledge and comprehension of the fundamentals of material science of metallic materials such as the relation between chemical composition, microstructure and properties of metallic materials. Ability to critically select the appropriate materials for application in civil engineering (fixation elements, reinforcement for concrete structures, high-strength steels).

Content
Fundamentals of metallic materials, crystal structure of metallic materials, defects, solidification,
Properties of metallic materials, physical (electrical, magnetic), mechanical (strength, deformation, fracture), chemical (corrosion resistance),
Most important alloys (steels, aluminium alloys, stainless steels)
Examples of application

Lecture notes
Lecture notes (in german) are distributed at the beginning of the course.
Reprints for selected topics.

Literature
Donald R. Askeland, Materialwissenschaften, Spektrum Akademischer Verlag, Heidelberg (1996)
ISBN 3-86025-357-3
Kapitel 1 - 13

3. Semester

Major Courses

Major in Construction and Maintenance Management

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<tbody>
<tr>
<td>101-0549-00L</td>
<td>Selected Topics on Legal Aspects in Civil Engineering</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>H. Briner, D. Trümpy</td>
</tr>
</tbody>
</table>

Abstract
Basic knowledge in public and private law of civil engineering. Examples of the subjects treated: space management, protection of the environment, legal procedures, standards for building technology and contracts.

Objective
Part 1: The students shall acquire basic knowledge of the public law concerning civil engineering: space management, conception of buildings, protection of the environment, procedures
Part 2: The students shall acquire basic knowledge of the private law concerning civil engineering

Data: 06.11.2018 12:57   Autumn Semester 2016   Page 172 of 1571
101-0577-00L  An Introduction to Sustainable Development in the Built Environment

Objective
This course provides an introduction to the notion of sustainable development when applied to our built environment.

In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environmental aspects.

The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.

Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.

After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.

Content
The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.

Students will learn the current understanding and definition of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

101-0587-00L  Workshop on Sustainable Building Certification

Abstract
Building labels are used to certify buildings and neighbourhoods in term of sustainability. Many different labels have been developed and can be used in Switzerland (LEED, DGNB, SNBS, Minergie). In this course the differences between the certification labels and its application on 3 emblematic case study buildings will be discussed.

Objective
After this course, the students are able to understand and use the different certification labels. They have a clear view of what the labels take into consideration and what they don't.

Content
Three buildings case study will be presented.

Different certification schemes, including LEED (American standard), DGNB (German Standard with Swiss adaptation), SNBS, MINERGIE-ECO and 2000-Watt-Society (Swiss standards) will be presented and explained by experts.

After this overall general presentation and in order to have a closer look to specific aspects of sustainability, students will work in groups and assess during one or two weeks this specific criteria on one of the case studies presented before. This practical hands on the label will end with a presentation and a discussion where we will highlight differences between the labels.

101-0439-00L  Introduction to Economic Analysis - A Case Study Approach with Cost Benefit Analysis in Transport

Abstract
This course will use a practical case study approach to introduce the students to economic analysis. The goal is to provide a methodological toolkit to conduct economic analysis of transportation projects and policies. The course will cover the principles of economic evaluation, including cost-benefit analysis, benefit-cost analysis, and cost-effectiveness analysis. The course will also introduce students to the use of spreadsheet tools and simulation models to perform economic analysis.

Objective
The objectives of the course are to:

- Introduce students to the principles of economic analysis
- Teach students how to perform economic analysis of transportation projects and policies
- Provide students with a methodological toolkit for conducting economic analysis
- Introduce students to the use of spreadsheet tools and simulation models for economic analysis

Content
The course will cover the following topics:

- Principles of economic evaluation
- Cost-benefit analysis
- Benefit-cost analysis
- Cost-effectiveness analysis
- Use of spreadsheet tools and simulation models for economic analysis

Lecture notes
All relevant information will be online available before the lectures. For each lecture slides of the lecture will be provided.

Literature
A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.
The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive the monetary values of non-market goods.

**Objective**
Familiarity with the essential methods of project appraisal

**Content**
Cost-Benefit-Analysis; multi-criteria analysis; European guidelines; stated response methods; travel cost approach and others; Valuation of travel time savings; valuation of traffic safety

**Lecture notes**
Handouts

**Literature**


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0419-00L</td>
<td>Railway Construction and Maintenance</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>U. A. Weidmann, P. Güldenapfel, M. Kohler, M. J. Manhart, further speakers</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture gives a deeper insight into track geometry, the interaction between track and vehicles as well as in construction and dimensioning of the track. Methods for the diagnosis of the state of the track and its forcast are shown. State-of-the-art maintenance strategies and technologies are presented.

**Objective**
The lecture gives a deeper insight into track geometry, the interaction between track and vehicles as well as in construction and dimensioning of the track. Methods for the diagnosis of the state of the track and its forcast are shown. State-of-the-art maintenance strategies and technologies are presented.

**Content**
Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forcast; track maintenance and related methods

**Lecture notes**
The slides will be made available.

**Literature**
A list with related technical literature will be handed out.

**Prerequisites / notice**
The lecture Railway Infrastructures (Transportation II) is recommended.

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### Major in Geotechnical Engineering

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>101-0339-00L</td>
<td>Environmental Geotechnics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. M. Plötze</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risque management, remediation and reclamation techniques as well as monitoring systems.

**Objective**
Lecture: Deepen the knowledge on selected topics of underground construction. Exercises: Conceptual solutions of complex problems.

**Content**

**Lecture notes**
Autographieblätter

**Literature**
Empfehlungen

**Prerequisites / notice**
Prerequisite: BSc course "Tunnelling", MSc courses "Tunnelling I" and "Tunnelling II".

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0359-00L</td>
<td>Physical Modelling in Geotechnics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>to be announced</td>
</tr>
</tbody>
</table>

**Abstract**
Aspects of both physical modelling in geotechnical engineering complemented by application of numerical modelling; appreciation of typical mechanisms pertaining to ultimate & serviceability limit state; influence on resulting design methods

**Objective**
Leading to an appreciation of the typical mechanisms pertaining to ultimate & serviceability limit state. Influence on resulting design methods.
Principles of physical modelling:
Centrifuge (physics, scaling laws, errors)
Experimental methods:
Geotechnical (sand/clay model making, site investigation), mechanical (packages, actuators), electronic (data acquisition)
Application of physical modelling for typical geotechnical problems, validated or calibrated by finite element analysis (learnt and applied in an earlier course).
Review of mechanisms observed, comparison between modelling, numerical and/or classical plasticity methods, implications for design.

From:- Foundations (shallow and deep), bridge abutments, reinforced soils, soil nailing & anchorages, tunnels & deep excavations, earthquake effects, dynamic problems, environmental geomechanics, transport processes, dams, embankments & slopes, cold regions engineering.

Lecture notes
- Handout notes,
- Example worksheets
  - http://geotg.lge.ethz.ch

Literature

Prerequisites / notice
A simple soil structure interaction boundary value problem will be selected (e.g., foundation, embankment, slope) as the exercise topic, which will modelled, in various forms, throughout the course. A predictive (class A) numerical analysis will be carried out by the students, followed by a centrifuge test on the same geometry to validate the numerical calculations. Subsequently a Class C2 numerical analysis will be conducted, calibrated by the physical modelling event.

101-0367-00L Geotechnical Engineering in Transportation
W 3 credits 2G  C. Rabaiotti

Abstract
Road design criteria, Technology of road construction materials, geotechnical testing methods in Laboratory and in situ, Planning, monitoring and interpretation of soil field tests, Soil classification for traffic construction, Compaction of road structures and dams, Frost characteristics of soil materials, soil stabilization

Objective
Aim of the course is to teach students the most important aspects of the road structure, its building and design methods. An essential part of the course is devoted to understand the influence of the in situ conditions: soil, underground, climate, water, as well as of the characteristics of building materials and of road surface on the durability of the pavement.

Content
Road design criteria, Technology of road construction materials, geotechnical testing methods in Laboratory and in situ, Planning, monitoring and interpretation of soil field tests, Soil classification for traffic construction, Compaction of road structures and dams, Frost characteristics of soil materials, soil stabilization

Lecture notes
- Autographie, Uebungsblätter, Handouts

Literature
- "Mauerwerk", Norm SIA 266, 2015
- "Mauerwerk - Ergänzende Festlegungen", Norm SIA 266/1, 2015
- "Mauerwerk, Bemessungsbeispiele zur Norm SIA 266", SIA Dokumentation D0257, 2015

Prerequisites / notice
In den Vorlesungen und Übungen werden verschiedene Demonstrationsmaterialien verwendet.

Voraussetzungen: Grundlagenkenntnisse in "Bodenmechanik/Grundbau" sowie in "Projektierung von Verkehrsanlagen"

### Major in Structural Engineering

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>101-0119-00L</td>
<td>Structural Masonry</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>N. Mojsilovic</td>
</tr>
</tbody>
</table>

**Abstract**
Knowledge of the engineering properties of materials for masonry construction.
Technical understanding of the structural behaviour of load-bearing masonry structures subjected to in-plane forces and combined actions.
Develop a technical competence for design procedures for load-bearing masonry structures by means of exercises.

**Objective**
Knowledge of the engineering properties of materials for masonry construction.
Technical understanding of the structural behaviour of load-bearing masonry structures subjected to in-plane forces and combined actions.
Develop a technical competence for design procedures for load-bearing masonry structures by means of exercises.

**Content**
Historical Development of Masonry Construction
Detailing and Execution
Construction Materials
Structural Behaviour and Modelling
Structural Analysis and Dimensioning
Reinforced Masonry
Seismic Behaviour

**Lecture notes**
- Lecture notes

**Literature**
- "Mauerwerk", Norm SIA 266/1, 2015
- "Mauerwerk", Norm SIA 266/2, 2015

**Prerequisites / notice**
Structural Concrete III

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<tr>
<th>Number</th>
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<th>ECTS</th>
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</thead>
<tbody>
<tr>
<td>101-0129-00L</td>
<td>Existing Structures</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>T. Vogel</td>
</tr>
</tbody>
</table>

**Abstract**
Treatment of the topic primarily from the perspective of a consulting engineer dealing with a single object.
Elaboration of a systematic procedure for respective projects. Consolidation for concrete structures and extension to other construction methods.

**Objective**
Treatment of the topic primarily from the perspective of a consulting engineer dealing with a single object.
Elaboration of a systematic procedure for respective projects. Consolidation for concrete structures and extension to other construction methods.

**Content**
Systems of existing structures, examination (condition survey, condition examination, recommendation of remedial measures), non-destructive testing methods, natural stone masonry, strengthening methods (esp. plate bonding)

**Lecture notes**
- Lecture notes

**Literature**
- Normen SIA 269, 269/1 bis 269/6, SIA-Dokumentationen D 0239 und D 0240 der Einführungskurse

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>101-0149-00L</td>
<td>Plate and Shell Structures</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>T. Vogel, S. Fricker</td>
</tr>
</tbody>
</table>

**Abstract**
Basic load bearing behaviour of plate and shell structures
Comprehension of basic load bearing behaviour of plate and shell structures; knowledge of typical applications of different materials, ability to reasonably interpret and check results of numerical calculations; establish access to technical literature.
Basic theoretical and procedural concepts of the method of finite elements (FE) for the analysis of nonlinear & dynamic systems are introduced. Kinematic and material nonlinear effects and the dynamic analysis of structures in terms of modal and time domain analysis are described.

The course is complemented by Homework Sessions using computing tools and FE software such as MATLAB, ABAQUS & ANSYS.

The following advanced topics are covered: 1) behavior and non-linear response of structural systems under earthquake excitation; 2) seismic behavior and design of moment frame, braced frame and shear wall structural systems; 3) design structural systems.

After successfully completing this course the students will be able to:
1. Use the knowledge of nonlinear dynamic response of structures to interpret the design code provisions and apply them in seismic design structural systems.
2. Explain the seismic behavior of moment frame, braced frame and shear wall structural systems and successfully design such systems to achieve the performance objectives stipulated by the design codes.
3. Determine the performance of structures under earthquake loading using modern performance assessment methods and analysis tools.

This course completes the series of two courses on seismic design of structures at ETHZ. Building on the material covered in Seismic Design of Structures I, the following advanced topics will be covered in this course: 1) behavior and non-linear response of structural systems under earthquake excitation; 2) seismic behavior and design of moment frame, braced frame and shear wall structures; 3) fundamentals of seismic isolation; and 4) assessment and retrofit of existing buildings. These topics will be discussed from the standpoint of performance-based design.

The electronic copies of the learning material will be uploaded to ILIAS and available through myStudies. The learning material includes the lecture presentations, additional reading, and exercise problems and solutions.

Useful Reading:
Prohibiting Seismic Risk Analysis and Management for Civil Systems

Abstract
Advanced topics covered in this course are: 1) probabilistic seismic hazard analysis; 2) probabilistic seismic risk analysis; 3) seismic risk management using structural and financial engineering means; and, time permitting, 4) advanced topics in systemic probabilistic risk evaluation.

Objective
After successfully completing this course the students will be able to:

1. Gather the necessary data and conduct a probabilistic seismic hazard analysis for a site.
2. Gather the necessary data and conduct a probabilistic vulnerability analysis of a building or an element of a civil infrastructure system at a site.
3. Design structural and/or financial engineering solutions to mitigate the seismic risk at a site.

Content
This course extends the series of two courses on seismic design of structures at ETHZ and introduces the topic of probabilistic seismic risk analysis and seismic risk management for the build environment and civil infrastructure systems. The following advanced topics will be covered in this course: 1) probabilistic seismic hazard analysis; 2) probabilistic seismic risk analysis; 3) seismic risk management using structural and financial engineering means; and, time permitting, 4) advanced topics in systemic probabilistic risk evaluation.

Lecture notes
The electronic copies of the learning material will be uploaded to ILIAS and available through myStudies. This will include the lecture notes, additional reading, and exercise problems and solutions. There is no textbook for this course.

Literature
Reading material:
- Jack R Benjamin, C. Allin Cornell (2014) Probability, Statistics, and Decision for Civil Engineers
- EERI Monograph MNO-10, Earthquake Engineering Research Institute.
- Earthquake Engineering: From Engineering Seismology to Performance-Based Engineering, Yousef Borzorgnia and Vitelmo Bertero, CRC Press, 2004

References:
- Norm SIA 261: Einwirkungen auf Tragwerke (Actions on Structures), Schweizerischer Ingenieur- und Architekten-Verein, Zürich, 2003

Software:
- Bispec: software for unidirectional and bidirectional dynamic time-history and spectral analysis of a simple dynamic system.
  http://egsols.com/Bispec.aspx
- OpenSees: Open System for Earthquake Engineering Simulation, is an object-oriented, open-source software framework.
  http://opsensees.berkeley.edu/

Prerequisites / notice
ETH Seismic Design of Structures I course (101-0188-00), or equivalent. Students are expected to understand the seismological nature of earthquakes, to characterize the ground motion excitation, to analyze the response of elastic single- and multiple-degree-of-freedom systems to earthquake excitation, to use the concept of response and design spectrum, to compute the equivalent seismic loads on simple structures, and to perform code-based seismic design of simple structures.

Wood and Wood Composites

Abstract

Objective
Knowledge of characteristic properties of wood as an anisotropic and porous material and their consideration in structural timber design.

Content
Characteristics of wood as an anisotropic and porous material and their consideration in structural timber design. History, ecology, structure of timber, drying, material properties, influence of moisture and creep, grading, Durability. Material properties and field of applications of solid timber, glued laminated timber and wood composites.

Lecture notes
Power Point slides. Further literature.

Literature

Prerequisites / notice
Die Vorlesung ist mit einer halbtägigen Exkursion verbunden.

Major in Transport Systems

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
101-0439-00L | Introduction to Economic Analysis - A Case Study Approach with Cost Benefit Analysis in Transport | W | 6 credits | 4G | K. W. Axhausen, R. Schubert

Abstract
The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive the monetary values of non-market goods.

Objective
The students will be able to analyse digital signals and systems in time-, z-, and frequency domains, and create, implement, and identify digital systems. The examples and sample data are measured from civil structures.

Content
Familiarity with the essential methods of project appraisal

Cost-Benefit-Analysis; multi-criteria analysis; European guidelines; stated response methods; travel cost approach and others; Valuation of travel time savings; valuation of traffic safety

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Autumn Semester 2016
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Railway safety strategies
U. A. Weidmann

The collection and the methods of statistical and geographical analysis of road accidents are important fundamentals of this course. Safety aspects in design of urban roads are discussed and measures for improving the safety situation are presented. Procedures of infrastructure safety management for administrations and police are another topic.

Objective
Imparting knowledge base about road safety and the event of accident, presenting possibilities to increase road safety

Content
Accident origin, collection of road accidents, statistical (descriptive and multivariate, accident prediction models) and geographical analysis of road accidents, risk analysis and rehabilitation measures, road safety instruments for infrastructure with focus on road safety audit, Swiss and international transport policy

Literature

Further literature: will be presented during the course

References will be included in the lecture notes. An additional list of literature will be given during the course.

Handouts


Content
(1) Transport and administrative policy: Goals of the state related to public transports, governmental activities in public transport, regulation.
(2) Business management in public transport enterprises: goals of public transport companies, goals of the business management; management of public transport on the different management levels, business organization. (3) Marketing, advertising and pricing: Fundamentals and goals; marketing strategies and concepts in public transports; marketing tools; putting marketing into action. (4) Quality control: Quality in transport systems; goals of quality management; structuring quality control measures; collecting quality data in an operating service; use of quality control systems for service optimization.

Lecture notes
Course notes will be provided in German. Slides will be made available.

Literature
References to technical literature will be included in the course script. An additional list of literature will be given during the course.

Prerequisites /
Lectures System and Network Planning as well as Systems Dimensioning and Capacity recommended.

101-0579-00L Infrastructure Maintenance Processes

<table>
<thead>
<tr>
<th>Objective</th>
<th>Abstract</th>
<th>Content</th>
<th>Literature</th>
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<tbody>
<tr>
<td>To equip students with tools to be used to evaluate infrastructure and the level of service being provided from infrastructure.</td>
<td>This course provides an introduction to the tools that can be used to evaluate infrastructure. In particular tools: - to measure the level of service being obtained from infrastructure, - to predict slow changes in infrastructure over time, and - to predict fast changes in infrastructure over time.</td>
<td>Levels of service, Reliability of infrastructure, Availability and maintainability of infrastructure, Mechanistic-empirical models, Regression analysis, Event trees, Fault trees, Markov chains, Neural networks, Bayesian networks, Conclusion.</td>
<td>All necessary materials (e.g. transparencies and hand-outs) will be distributed before class.</td>
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</table>

101-0509-00L Infrastructure Management 1: Process

<table>
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<tr>
<th>Objective</th>
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<th>Literature</th>
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<tr>
<td>Upon completion of the course, students will understand the steps required to manage infrastructure effectively, understand the complexity of these steps, and have an overview of the tools that they can use in each of the steps.</td>
<td>The course provides an introduction to the steps included in the infrastructure management process. The lectures are given by a mixture of external people in German and internal people in English.</td>
<td>The infrastructure management process and guidelines, Knowing the infrastructure - Dealing with data, Establishing goals and constraints, Establishing organization structure and processes, Making predictions, Selecting strategies, Developing programs, Planning interventions, Conducting impact analysis, Reviewing the process.</td>
<td>Appropriate reading material will be assigned when necessary.</td>
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103-0417-02L Theory and Methodology of Spatial Planning

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<th>Objective</th>
<th>Abstract</th>
<th>Content</th>
<th>Literature</th>
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<tr>
<td>The participants know the interdependencies between the assessment of a situation, decision making, knowledge and language. They know the nature of a decision dilemma and maximes, how to deal with it. Especially they learn that the requirement of information for a decision depends upon the preferences of the deciding actor. They are also familiar with difficulties and pitfalls within these contexts and know what can be done against it.</td>
<td>In order to solve problems in spatial planning it is necessary to explore actions and to judge them: finally, one has to argue why a certain option should be preferred to others. Assessments of the situation are the basis for the problems to treat. Specific knowledge, represented in an adequate manner, is required.</td>
<td>Assessment of the situation, deciding, language and knowledge are the main parts.</td>
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101-0491-00L Agent Based Modeling in Transportation

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<tr>
<th>Objective</th>
<th>Abstract</th>
<th>Content</th>
<th>Literature</th>
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<tr>
<td>The objective of this course is to make the students familiar with agent-based models and in particular with the software MATSim. They will learn the pros and cons of this type of approach versus traditional transport models and will learn to use the simulation. They will design a policy study and run simulations to evaluate the impacts of the proposed policies.</td>
<td>The main topics of the lecture are: 1) Introduction to the agent-based paradigm and overview on existing agent-based models in transportation, including MATSim, 2) Learn how to setup MATSim for policy analysis, 3) Learn about the interfaces available to enhance the software (includes Java programming), 4) Create, run and analyse a policy study.</td>
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The main topics are:
1) Introduction to the agent-based paradigm and overview on existing agent-based models in transportation, including MATSim
2) Introduction of basic building blocks of simulation approaches (random numbers generation, experimental design, variance control, response surface estimation)
3) Revision of the key submodels and their parameters and concepts (value of time, Wardrop (Nash) equilibrium, etc.)
4) Learn how to setup MATSim for policy analysis
5) Learn about the interfaces available to enhances the software (includes Java programming)
6) Create, run and analyse a policy study

MATSim

Additional relevant readings, mostly scientific articles, will be recommended throughout the course.

Simulation of Traffic Operations
Abstract
The course introduces basics of microscopic traffic simulation, including model development, calibration, validation, data analysis, identification of strategies for improving traffic performance, and evaluation of such strategies. The modelling software used is VISSIM.

Objective
The objective of this course is to introduce basic concepts in microscopic traffic simulation and conduct a realistic traffic engineering project from beginning to end. The students will first familiarize themselves with microscopic traffic simulation models. They will then use a simulation for modeling and analyzing the traffic operations. The emphasis is not only on building the simulation model, but also understanding of the models behind and logically evaluating results. The final goal is to make valid and concrete engineering proposals based on the simulation model.

Content
In this course the students will first learn some microscopic simulation concepts and then complete a traffic engineering project with microscopic traffic simulator VISSIM.

Microscopic simulation concepts will include:
1) Car following models
2) Lane change models

Specific tasks for the project will include:
1) Building a model with the simulator VISSIM in order to replicate and analyze the traffic conditions measured/observed.
2) Calibrating and validating the simulation model.
3) Redesigning/extend the model to improve the traffic performance.

Lecture notes
The lecture notes and additional handouts will be provided before the lectures.

Literature
Additional literature recommendations will be provided at the lectures.

Prerequisites / notice
There are no strict preconditions in terms of which lectures the students should have previously attended. However, it is expected that the students have some experience with some high level programming language (i.e. C, C++, Fortran or Java). If this is not the case, attending the additional java exercises (101-0491-00U) is strongly encouraged.

Selected Topics on Hydraulic Engineering
Prerequisites: 101-0247-01L Hydraulic Engineering II or equivalent course

Abstract
The lecture focuses on selected topics in hydraulic engineering, water management and aquatic ecology relating to hydropower and flood protection projects.

Objective
To deepen knowledge on special aspects in hydraulic engineering and to understand the procedures and the planning sequence of hydropower projects

Content
Different selected topics in hydraulic engineering will be focused on, e.g. dam safety, possible problems at reservoirs like sedimentation or natural hazards by impulse waves, the hydraulics of river flows, spillways and intake structures at dams and weirs, hydropower and ecology like fish-ecological aspects at low-head hydropower plants and eco-hydraulics like flow-vegetation interaction. Another focus will be put on typical approaches and procedures in the planning process of hydropower projects.

Lecture notes
Lecture notes/handouts will be available online.

Literature
is specified in the lecture.

Prerequisites / notice
Students need to know some basic road transport concepts. The course Road Transport Systems (Verkehr III), or simultaneously taking the course Traffic Engineering is encouraged. The course Transport Simulation (101-0438-00 G) and previous experience with VISSIM is helpful but not mandatory.

Applied Glaciology

Abstract
We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

Objective
To understand the fundamental physical processes in glaciology.
To learn some basic numerical modelling techniques for glacier flow.
To identify glaciological hazards and to learn some assessment and mitigation possibilities.

Content
Basics in physical glaciology
Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges
Ice falls, ice avalanches
Glacier floods
Lake ice and bearing capacity

Lecture notes
Handouts are available

Literature
Relevante Literatur wird während der Vorlesung angegeben.

Prerequisites / notice
Für aktuelle Fallbeispiele werden risikobasierte Massnahmen bei glaziologischen Naturgefahren diskutiert.

Hydraulics of Engineering Structures

Abstract

Objective

Content

Prerequisites / notice

Voraussetzungen: Es werden Grundkenntnisse in Mechanik und Physik vorausgesetzt.
Abstract
Hydraulic fundamentals are applied to hydraulic structures for wastewater, flood protection and hydropower. Typical case studies from engineering practice are further described.

Objective
Understanding and quantification of fundamental hydraulic processes with particular focus on hydraulic structures for wastewater, flood protection and hydropower.

Content
1. Introduction & Basic equations
2. Losses in flow & Maximum discharge
3. Uniform flow & Critical flow
4. Hydraulic jump & Stilling basins
5. Backwater curves
6. Weirs/End overfalls & Venturi
7. Mobile discharge measurements & Culverts/resistors/inverted siphons
8. Fall manholes & Vortex drop
9. Conjunctions & Shock waves at abrupt wall deflections
10. Air/water flows and bottom outlets
11. Driftwood retention racks
12. Vegetated flows - Introduction
13. Vegetated flows - Application
14. Summary & questions/preparations for examination

Lecture notes
Text books

Literature

Exhaustive references are contained in the suggested text book.

102-0215-00L Urban Water Management II W 3 credits 2G M. Maurer, P. Staufer

Abstract

Objective
Consolidation of the basic procedures for design and operation of technical networks in water engineering.

Content
Demand Side Management versus Supply Side Management
Optimierung von Wasserverteilnetzen
Druckstöße
Kalkausfällung, Korrosion von Leitungen
Hygiene in Verteilsystemen
Siedlungshydrologie: Niederschlag, Abflussbildung
Instationäre Strömungen in Kanalisationen
Stofftransport in der Kanalisation
Einleitbedingungen bei Regenwetter
Versickerung von Regenwasser
Generelle Entwässerungsplanung (GEP)

Lecture notes
Written material and copies of the overheads will be available.

Prerequisites / notice
Prerequisite: Introduction to Urban Water Management

101-0619-00L Mechanics of Building Materials W 3 credits 2G F. Wittel

Abstract
Material models comprise our knowledge on the physical behavior of materials. Based on a short introduction to solid mechanics, 3D material laws for elastic, visco-elastic behavior, plasticity and damage mechanics are discussed. We focus on material laws for concrete, metals, wood and other composites, how to obtain parameters from mechanical tests and their application in FEM calculations.

Objective
This introductory course aims to bridge the gap between phenomenological, qualitative comprehension of processes in building materials, their characterization in mechanical testing and the ability to apply those for practical design purposes via constitutive models.

Upon completion of the course you should be able to:
- classify different material behavior (e.g. linear/non-linear elastic, elasto-plastic, creep) with respect to types of constitutive material models (total /incremental strain models, damage / plasticity models, linear visco-elasticity),
- review how incremental strain models (e.g. elasto-plastic) are algorithmically implemented in Finite Element software (UMat of Abaqus),
- formulate the main approach and assumptions to the most import models for building materials and discuss their limitations,
- propose experimental campaigns for obtaining relevant material parameters for non-linear material models.

Content
- Introduction to constitutive models for materials
- Fundaments of mechanics of materials
- Cauchy-, hyper- and hypoelastic material descriptions
- Constitutive Models for Concrete (non-linear elastic)
- Introduction to metal and concrete plasticity
- Introduction to ABAQUS UMAT Programming
- Damage continuum mechanics
- Linear visco-elastic materials

Lecture notes
Will be provided during the lecture.

101-0639-01L Science and Engineering of Glass and Natural Stone W 3 credits 2G F. Wittel, T. Wangler in Construction

Abstract
The course offers an overview of relevant practical issues and present technological challenges for glass and natural stones in constructions. Students gain a good knowledge of the basics of glasses and natural stones, their potential as engineering materials and learn to apply them in the design of civil engineering constructions and to evaluate concepts.
Glass is increasingly used in constructions to ease the construction process, as functional insulation barrier, even for structural applications of impressive size. While everyone has experienced the innovation potential of glass in the last decade, products from natural stone suffer from an unjustified traditional image that often originates from a lack of understanding of the material and its combination with other materials. Culturally important structures often are made from natural stone and their conservation demands an understanding of their deterioration mechanisms, the causes of which can be applied to other civil engineering materials. Designers and engineers need the knowledge to reconcile materials and system behavior with the entire processing, handling, integration and life time in mind. 

In this module students are provided with a broad fundamental as well as practice-oriented education on glass and natural stone in civil engineering applications. Present and future construction and building concepts demand for such materials with optimized properties.

Based on the fundamentals from the Bachelor course in materials by the end of this module, you should be able to:

- recognize and choose specific applications from the broad overview you were provided with,
- relate processing technologies to typical products and building applications and recognize (and explain typical damage related to wrong material choice or application,
- explain the nature of glassy and crystalline materials and interpret their physical behavior against this background,
- explain the major deterioration mechanisms in natural stone and how this relates to durability,
- analyze material combinations and appraise their application in future products as well as integration in existing constructions,
- summarize with appropriate guidance publications on a related topic in an oral presentation and short report.

Objective 
Glass is increasingly used in constructions to ease the construction process, as functional insulation barrier, even for structural applications of impressive size. While everyone has experienced the innovation potential of glass in the last decade, products from natural stone suffer from an unjustified traditional image that often originates from a lack of understanding of the material and its combination with other materials. Culturally important structures often are made from natural stone and their conservation demands an understanding of their deterioration mechanisms, the causes of which can be applied to other civil engineering materials. Designers and engineers need the knowledge to reconcile materials and system behavior with the entire processing, handling, integration and life time in mind. 

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- relate processing technologies to typical products and building applications and recognize (and explain typical damage related to wrong material choice or application,
- explain the nature of glassy and crystalline materials and interpret their physical behavior against this background,
- explain the major deterioration mechanisms in natural stone and how this relates to durability,
- analyze material combinations and appraise their application in future products as well as integration in existing constructions,
- summarize with appropriate guidance publications on a related topic in an oral presentation and short report.

Content
Lecture 1: An introduction to science and engineering of glass and natural stone in construction (FW/TW)

Lecture 2: Glass chemistry including historical development of glass composition, use of raw materials, melts, chemical stability and corrosion. (FW)

Lecture 3: Geology and mineralogy of stones used in construction. Formation processes, chemistry, crystal structure. (TW)

Lecture 4: Microscopic models for glassy materials. Physics of glass transition. From microscopic physical models to thermodynamics, rheology and mechanics of glassy materials. (FW)

Lecture 5: Stone properties and behavior: microstructure, density, porosity, mechanical properties (TW)

Lecture 6: Glass physics: Optical properties (transmission, reflection, emission, refraction, polarization and birefringence, testing methods); Mechanical properties (density, thermal, mechanical, electric properties, glass testing) (FW)

Lecture 7: Stone properties and durability: transport, moisture and thermal cycling (FW)

Lecture 8: Forming and processing of glass: (plate and molded glass, drawing, slumping, profiling etc.; Processing: Cutting, mechanical processing, tempering, gluing, bending, laminating of glass Surface treatments: coating, sputtering, enameling, printing, etching, chemical pre-stressing.) (FW)

Lecture 9: Durability: Salt crystallization, freezing, biodeterioration (TW)

Lecture 10: Glass products for civil engineering applications: (Molded glasses, fiber glass, foam glass, plate glass); construction glass (insulation glass, structural glass, protective glass, intelligent glass, codes); (FW)

Lecture 11: Conservation: Consolidation, cleaning, and other treatments (TW). Practical aspects (guest lecturer)

Lecture 12: Glass in constructions. (modelling, application and regulation, typical damage in glass) (FW)

Lecture 13: Student presentations; exam questions (FW/TW)

Prerequisites / notice
Werkstoffe I/II of the bachelor studies or equivalent introductory materials lecture.

Literature
Werkstoffe II script (download via the IFB homepage). Rest will be handed out in the lectures.

101-0659-01L Durability and Maintenance of Reinforced Concrete W 3 credits 2V B. Elsener, U. Angst

Objective
The course focuses on durability of RC structures, in particular the corrosion of steel in concrete. The main emphasis lies on understanding the mechanisms, design and execution aspects related to durability of new and existing structures. New methods and materials for preventative measures, condition assessment and repair techniques are treated with lectures and practice related exercises.

Understand the mechanism of deterioration of RC structures, in particular reinforcement corrosion.

Know the relevant parameters affecting durability of reinforced concrete, in particular cover depth, concrete quality, moisture, and the ways to control durability

Understand the current approaches for design for durability (exposure classes, prescriptive) and be aware of their limitations

Know the future performance-based models for durability design and the difficulties in defining input parameters (such as critical chloride content).

Know and understand different ways to improve durability of RC structures (e.g. stainless steel reinforcement)

Know the particular problems with post-tensioned structures and ways to overcome them (electrically isolated tendons).

Know and understand the non-destructive methods for inspection and condition assessment (especially half-cell potential mapping) and be aware of the limitations

Know and understand repair methods such as conventional repair, electrochemical methods (in particular cathodic protection)

Be aware of differences in performance of the new blended cements (especially CEM II with limestone) respect to the traditional Portland cement and the possible future problems for durability.
Content

Reinforced concrete combines the good compressive strength of concrete with the high tensile strength of steel and has proven to be successful in terms of structural performance and durability. However, there are instances of premature failure of reinforced concrete and prestressed concrete components due to corrosion of the reinforcing steel with very high economic implications of such damage. This course focuses on the chloride and carbonation induced corrosion of steel in concrete, presenting transport mechanisms and electrochemical concepts. The main emphasis lies on design and execution aspects related to durability of new and existing structures. New methods and materials for preventative measures, condition assessment and repair techniques are discussed. The course is a point of reference for engineers and materials scientists involved in research and practice of corrosion protection, rehabilitation and maintenance of reinforced concrete structures and components.

Content of the course in detail:

Lecture 1
Administrative issues, literature, what do students expect to learn? Introduction (economic relevance of durability, transition from building to maintenance). Fundamentals of corrosion and durability / Passivity and pitting corrosion

Lecture 2
Reinforced concrete / Corrosion protection / Degradation mechanism corrosion (chlorides/carbonation) / electrochemical mechanism / controlling parameters / cracks and spalling on surface, danger of localized corrosion

Lecture 3
Other degradation mechanisms: sulphate attack, ASR, frost attack
Various examples, frequency of occurrence of individual deterioration mechanisms

Lecture 4
Service life: initiation stage & propagation stage. Durability design: prescriptive approach, constructive detailing, importance of moisture for almost all degradation mechanisms. Performance based approach, simple diffusion approach for chloride ingress, Critical chloride content (influencing parameters)

Lecture 5
Stainless steel as reinforcing steel for concrete / different types of stainless steels / mechanical properties / corrosion resistance, passivity / coupling with black reinforcing steel / examples of application / life-cycle-costs

Lecture 6
Inspection and condition assessment I: visual inspection / destructive testing (chloride profiles, carbonation depth, thin section analysis, etc.)

Lectures 7
Inspection and condition assessment II: non-destructive testing (potential mapping, cover depth measurement, resistivity measurement). Potential mapping: measurement principle / effect of carbonated cover zone / effect of moisture / examples

Lecture 8
Post-tensioned structures / problem with existing structures: no NDT method / approach for protection (multiple barrier) / new systems with polymer ducts / electrically isolated tendons / fib guidelines / Swiss guideline / Monitoring techniques / Applications

Lecture 9
Repair methods I: conventional repair / coatings / inhibitors / limitations

Lecture 10
Repair methods II: electrochemical repair methods (ECR, ER, CP) / principles / electrochemical chloride removal (theory and examples) / electrochemical realkalization (theory and examples) / when can these methods be applied ? / cost aspects

Lecture 11
Repair methods III: cathodic protection (theory, technical solutions, anode systems, etc and examples). Monitoring of CP.

Lecture 12
New cements, issue of CO2 reduction. Effects of fly ash, slag, limestone on workability, diffusion coefficient, resistivity, pH (including a discussion of the pozzolanic reaction and it's consequences with respect to pH buffering Portlandite reserve). Discuss products on the Swiss market.

Lecture 13
Summary of most important points of this course given by the students. Open discussion about durability design, use of new cements, new materials and repair methods. Expected consequences for practice ? Course evaluation and time for asking questions.

Lecture notes
The course is based on the book
Slides of the lectures will be distributed in advance
Special hand outs and reprints for particular topics will be distributed

Literature

Prerequisites / notice
Students are encouraged to actively participate during the lectures. Students are expected to work on all the exercises (four). For one exercise a detailed written solution of the exercise has to be delivered (after the discussion).

Students should have passed the exams on Werkstoffe I and II.

101-0699-00L Bituminous Materials W 3 credits 2G M. Partl

Abstract
Introduction into special aspects of the mechanical and chemo-physical properties as well as the structure and application of bituminous materials for road and waterproofing application considering also new R&D trends

Objective
Introduction into special aspects of the mechanical and chemo-physical properties as well as the structure and application of bituminous materials for road and waterproofing application considering also new R&D trends

Content
Basics of mechanical behavior: Viscosity, rheological models, viscoelasticity, time-temperature superposition, fatigue, viscoplasticity. Bituminous binders: Tar-related issues, bitumen, natural asphalt, polymer modified bitumen, technological tests, mechanical-physical properties, binder classification, bitumen emulsions, foam bitumen. Asphalt pavements: material structure and concepts, production, mixture testing and characterization, mixture types, recycling. Waterproofing membranes: tack- coats, structure of polymer modified waterproofing membranes, production, typical tests, system-related properties, constrauction and application
Concrete is generally viewed as a durable construction material. However, the long-term performance of a concrete structure can be greatly compromised by early-age cracking. This course will explain how shrinkage of concrete leads to cracking and how control of shrinkage allows increasing the expected durability of a concrete structure. This course will begin with a brief introduction about hydration and microstructure development in cement paste and concrete. The students will learn the main causes of cracking at early ages, namely plastic, drying, thermal and autogenous shrinkage, with special emphasis on the driving mechanisms. The importance of concrete curing, especially in the first few days after casting, will be explained. Building on the knowledge of the driving forces of shrinkage, the way of action of shrinkage-reducing admixtures will be clarified and different applications illustrated. As an extension of external curing, the students will become familiar with internal water curing by means of saturated lightweight aggregate and superabsorbent polymer. Most concrete members are restrained by adjacent structures. When shrinkage is restrained, cracks may develop. The students will learn how to apply different criteria for assessing concrete cracking and how to retrieve the mechanical properties of the concrete, especially stiffness and creep, relevant for the calculations. In addition to macroscopic cracks, microcracking may occur in the cement paste due to inner restraint offered by the aggregates. Both macroscopic cracks and diffuse microcracking within a concrete may facilitate the ingress of harmful substances (e.g. chloride and sulfate ions) into the concrete; these may react with the concrete or with the reinforcement and create further deterioration. The students will acquire an understanding of the mechanisms of transport through cracked concrete, with special focus on experimental evidence and on techniques able to visualize the transport process and follow it in time. As a final outcome of the course, the students will be able to estimate the impact of cracking on the expected durability of concrete structures and to implement different types of measures to reduce the extent of cracking. Specific topics covered by the course:
- Hydration and microstructure development
- Plastic shrinkage
- Development of mechanical properties
- Thermal deformation
- Autogenous deformation
- Drying shrinkage
- Curing
- Shrinkage-reducing admixtures
- Internal curing: saturated lightweight aggregate and superabsorbent polymer
- Fracture and microcracking
- Transport in cracked concrete
- Impact of cracking on concrete durability

Lectures notes
For each lecture, lecture notes will be provided. In addition, one or two research papers for each lecture will be indicated as supportive information. The students will be also provided with a DVD containing the teaching material of a previous course on the same topic, including 16 hours of filmed lectures.

Literature
Copies of one to two research papers relevant to the topic of each lecture will be provided to the students as supportive information. A basic knowledge of concrete technology is preferable.

Prerequisites / notice
A basic knowledge of concrete technology is preferable.
Objective

The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:

- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations.

Content

- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

Lecture notes

yes

Literature


Prerequisites / notice

If we will have a large number of students, two dates for the exercises will be offered.

101-0637-10L  Structures of Wood and Function  W  3 credits  2G  I. Burgert, E. R. Zürcher

Abstract

The lecture Wood structure and function conveys basic knowledge on the microstructure of softwoods and hardwoods as well as general and species-specific relationships between growth processes, wood properties and wood function in the living tree.

Objective

Learning target is a basic understanding of the anatomy of wood and the related impact of endogenous and exogenous factors. The students can learn how to distinguish common central European wood species at the macroscopic and microscopic level. A deeper insight will be given by wood identification exercises for softwood species. Further the students will gain insight into the relationships between tree growth and wood properties with a specific focus on the wood function in the living tree.

Content

In an introduction to wood anatomy, the general structural features of softwoods and hardwoods will be explained and factors of diversity and variability will be discussed. A specific focus is laid on common central European tree species with relevance in the wood sector, which will be studied in macro- and microstructural investigations. For softwoods, exercises for the identification of species will be conducted. In the following, relationships between wood structure, properties and function in the living tree will be the focus of the lecture. Topics covered are mechanical stability and water transport, branches, reaction wood formation (compression wood, tension wood), spiral growth, growth stresses as well as adaptive growth of trees.

101-0637-20L  Fundamentals of Wood Elaboration and Woodmachining  W  3 credits  2G  I. Burgert, O. F. Klausler

Abstract

The lecture Wood processing conveys knowledge on technological properties of wood and wood-based materials as well as on industrial processes for the fabrication of a vast variety of wood products.

Objective

Learning target is a fundamental understanding of the dominating wood machining processes, which are applied to fabricate common wood products. Students will be introduced to the economic relevance of the renewable resource wood and are trained in its technological properties. The students will learn to identify the relationships between wood species and their properties as well as the suitable wood machining processes to fabricate targeted wood products.

Content

The general introduction shows the economic relevance of the resource wood in a global, European and Swiss context and reflects aspects of sustainability in wood production and certification. In terms of bulk wood products a specific focus is laid on sawn timber production and drying processes. With regard to wood veneer production, steaming, veneer cutting and assembly to veneer lumber products are presented. Further the common technologies for the production of particle boards and fibre boards as well as paper will be discussed. In the following, the topics are related to wood gluing and wood protection as well as potentials and limitations in the application of wood and wood-based products. At the end of the lecture an excursion to a Swiss wood manufacturer is planned, in order to facilitate practical experience.

151-0735-00L  Dynamic Behavior of Materials and Structures  W  4 credits  2V+2U  D. Mohr

Abstract

Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme loadings during manufacturing, crash, impact and blast events.

Objective

Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering.

Content

Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;

Lecture notes

Various books will be recommended covering the topics discussed in class

Literature

Slides of the lectures, relevant journal papers and users manuals will be provided.

Prerequisites / notice

Course in continuum mechanics (mandatory), finite element method (recommended)

151-0513-00L  Mechanics of Soft Materials and Tissues  W  4 credits  3G  A. E. Ehret

Abstract

An introduction to concepts for the constitutive modelling of highly deformable materials with non-linear properties is given in application to rubber-like materials and soft biological tissues. Related experimental methods for materials characterization and computational methods for simulation are addressed.
The objective of the course is to provide an overview of the wide range of non-linear mechanical behaviors displayed by soft materials and tissues together with a basic understanding of their physical origin, to familiarize students with appropriate mathematical concepts for their modelling, and to illustrate the application of these concepts in different fields in mechanics.

Soft solids: rubber-like materials, gels, soft biological tissues
Non-linear continuum mechanics: kinematics, stress, balance laws
Mechanical characterization: experiments and their interpretation
Constitutive modeling: basic principles
Large strain elasticity: hyperelastic materials
Rubber-elasticity: statistical vs. phenomenological models
Biomechanics of soft tissues: composites, anisotropy, heterogeneity
Dissipative behavior: examples and the concept of internal variables.

Accompanying learning materials will be provided or made available for download during the course.

A good knowledge base in continuum mechanics, ideally a completed course in non-linear continuum mechanics, is recommended.

### Projects

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<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0198-01L</td>
<td>Project on Construction Engineering</td>
<td>W</td>
<td>9</td>
<td>18A</td>
<td>Professors</td>
</tr>
<tr>
<td>101-0298-01L</td>
<td>Project on Hydraulic Engineering and Water</td>
<td>W</td>
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<td>Lecturers</td>
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<tr>
<td>101-0398-01L</td>
<td>Project on Geotechnical Engineering</td>
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<tr>
<td>101-0498-01L</td>
<td>Project on Transport Systems</td>
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<td>Lecturers</td>
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<tr>
<td>101-0598-01L</td>
<td>Project on Construction and Maintenance</td>
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<td>Lecturers</td>
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<tr>
<td>101-0698-01L</td>
<td>Project on Materials and Mechanics</td>
<td>W</td>
<td>9</td>
<td>18A</td>
<td>Lecturers</td>
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### Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

### Electives ETH Zurich

Course Catalogue of ETH Zurich

### Recommended Electives of Master Programme

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<th>Number</th>
<th>Title</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>051-0781-16L</td>
<td>Costuire correttamente/Constructing Correctly: Curve and Fold to Bear Loads and Forces</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>G. Birindelli</td>
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In line with the approach of P.L. Nervi's book, our study is based on factors that, outlined by him, are still today all the more relevant as a lesson for architecturally and structurally justified buildings. We will observe selected buildings both of our time and of the past for their space, architecture and construction, understand them and interpret them according to universal values of design.
During the course, students will learn about different design thinking methods and tools. This will enable them to:

- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

The main thread of this course, that runs over two semesters (*), is buildings of all ages that could be categorized under notions such as « most viewed », « most technically daring », « most unknown », « most discussed » or « most worthy of discussion », and carry instructive aspects of the teachings of Pier Luigi Nervi ("costruire correttamente"). In the lecture, these buildings will be investigated on-the-spot, described from the designers' point-of-view and will be commented on with reference to any redesign resulting from the interplay of architectural and structural concepts. Harmonies and discords should be discovered. Occasionally there will be guest lectures. These people, who were directly involved with a certain building, will portray the emergence and development of the project. In this sense, the course is also intended for civil / structural engineering students and presents a possible bridge between the two prospective project partners - architect and engineer.

The purpose of this course is to equip the students with methods and tools to tackle a broad range of problems. Following a design thinking approach, students will work in teams to solve a set of design challenges that are organized as a one-week, a three-week, and a final six-week project in collaboration with an external project partner.

Design Thinking: Human-Centred Solutions to Real World Challenges

Due to didactic reasons, the number of participants is limited to 30.

All interested students are invited to apply for this course by sending a one-page motivation letter until 14.9.16 to Florian Rittiner (frittiner@ethz.ch).

Additionally please enroll via mystudies. Places will be assigned after the first lecture on the basis of your motivation letter and commitment for the class.

The goal of this course is to engage students in a multidisciplinary collaboration to tackle real world problems. Following a design thinking approach, students will work in teams to solve a set of design challenges that are organized as a one-week, a three-week, and a final six-week project in collaboration with an external project partner.

The students will work in multidisciplinary teams on a set of challenges that are organized as a one-week, a three-week, and a final six-week project with an external project partner. In this course, the students will learn about the different Design Thinking methods and tools that are needed to generate deep insights, to engage in collaborative ideation, rapid prototyping and iterative testing.

Design Thinking is a deeply human process that taps into the creative abilities we all have, but that get often overlooked by more conventional problem solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as functional, and to express ourselves through means beyond words or symbols. Design Thinking provides an integrated way by incorporating tools, processes and techniques from design, engineering, the humanities and social sciences to identify, define and address diverse challenges. This integration leads to a highly productive collaboration between different disciplines.

The main objective of this course is to provide students with some basic tools to analyze transport policy decisions from an economic perspective. Can economics help us reduce road congestion problems? Should drivers be asked to pay for using urban roads? Should public transport tariffs depend on how roads are priced? How should the investment in transport infrastructure be financed? These are some of the questions that students should be able to tackle after completing the course.

Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.
COURSE OUTLINE (preliminary):
1. Introduction
2. Travel demand:
   a. Travel cost and value of time
   b. Mode choice
3. Road congestion and first-best pricing
   a. Static congestion model
   b. Dynamic congestion models
   c. Examples: London Congestion Charge, Stockholm Congestion Charge
4. Second-best pricing
   a. Pricing roads with unpriced alternatives. Examples: tolled and toll-free highways
   b. Public transport: pricing with road congestion and with (or without) road tolls
5. Investment in infrastructure: public transport and roads
   a. Roads: Investment with and without pricing
   b. Induced demand
   c. Economies of scale/density in public transport
6. Topics:
   a. Political economy of road pricing: why do we see road pricing in so few cities (London, Stockholm...) and not in many other cities (NYC, Manchester, Paris...)?
   b. What are the alternatives to road pricing to reduce congestion? Parking tariffs, traffic regulation (speed bumps, low emission zones), road space reduction. Examples: Zurich, San Francisco (SFpark), Paris.
   c. Transport and land use: value of housing and transport services. Road congestion, transport subsidies and urban sprawl.

Lecture notes
Course slides will be made available to students prior to each class.

Literature
Course slides will be made available to students prior to each class.

SYLLABUS (preliminary):

Additional material:
Part 1 to 5: textbook: Small and Verhoef (The economics of urban transportation, 2007).
Part 6: Topics to be covered on research papers/case studies.

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-BAUG.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Master’s Thesis

Number Title Type ECTS Hours Lecturers
101-0010-00L Master’s Thesis O 24 credits 47D Supervisors

Abstract
The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

Objective
To work independently and to produce a scientifically structured work.

Content
The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

Civil Engineering Master - Key for Type

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
<td></td>
<td></td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td></td>
<td></td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td></td>
<td></td>
<td>Suitable for doctorate</td>
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Key for Hours

<table>
<thead>
<tr>
<th>Letter</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Know effects of work design on competence, motivation, and well-being


The seminar helps during the master thesis in order to enable a successful completion of the thesis.

E. de Bruin

Work Design and Organizational Change

Human Movement Sciences Master

Major in Motor Control and Motor Learning

Compulsory Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tr>
<td>557-1008-00L</td>
<td>Seminar</td>
<td>O</td>
<td>3</td>
<td>2S</td>
<td>E. de Bruin</td>
</tr>
<tr>
<td>Abstract</td>
<td>The master thesis accompaniment seminar with ethical discussions, obtaining research plans, literature searches, critical discussion of original publications, and obtaining possible solutions when confronted with experimental problems.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>The seminar helps during the master thesis in order to enable a successful completion of the thesis.</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Findet nach Vereinbarung statt.</td>
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Electives

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kozerke, K. P. Prüssmann, M. Rudin</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.</td>
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<tr>
<td>Objective</td>
<td>To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function, transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.</td>
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</tr>
<tr>
<td>Content</td>
<td>- X-ray imaging</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>- Computed tomography</td>
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<tr>
<td></td>
<td>- Single photon emission tomography</td>
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<tr>
<td></td>
<td>- Positron emission tomography</td>
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<td></td>
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<tr>
<td></td>
<td>- Magnetic resonance imaging</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Ultrasound/Doppler imaging</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes and handouts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming</td>
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</tr>
</tbody>
</table>

| 227-0386-00L  | Biomedical Engineering                          | W    | 4    | 3G    | J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong |
| Abstract      | Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined. |
| Objective     | Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations. |
| Lecture notes | Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzinno |
| Literature    | Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011 |
| Prerequisites / notice | Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming |

| 227-1051-00L  | Systems Neuroscience (University of Zurich)      | W    | 6    | 2V+1U | D. Kiper |
| Abstract      | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: INI415 |
| Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html |
| Objective     | This course focuses on basic aspects of central nervous system physiology, including perception, motor control and cognitive functions. |
| Content       | To understand the basic concepts underlying perceptual, motor and cognitive functions. |
| Lecture notes | None |
| Prerequisites / notice | none |

| 363-0301-00L  | Work Design and Organizational Change           | W    | 3    | 2G    | G. Grote |
| Abstract      | Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings. |
| Objective     | - Know effects of work design on competence, motivation, and well-being |
|              | - Understand links between design of individual jobs and work processes |
|              | - Know basic processes involved in systematic organizational change |
|              | - Understand the interaction between organization and technology and its impact on organizational change |
|              | - Understand relevance of work design for company performance and strategy |
|              | - Know and apply methods for analyzing and designing work |

Data: 06.11.2018 12:57  Autumn Semester 2016
On completion of this course students will be able to demonstrate:

Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding.

This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

See course website: http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html

Lecture slides and case material

**Content**

- Work design: From Adam Smith to job crafting
- Effects of work design on performance and well-being
- Approaches to analyzing and designing work
- Modes of organizational change and change methods
- Balancing stability and flexibility in organizations as design criterion
- The organization-technology interaction and its impact on work design and organizational change
- Example Flexible working arrangements
- Strategic choices for work design

**Literature**

A list of required readings will be provided at the beginning of the course.

**Prerequisites / notice**

The course includes the completion of a course project to be conducted in groups of four students. The project entails applying a particular method for analyzing and designing work processes and is carried out by means of interviews and observations in companies chosen by the students.

**363-0790-00L Technology Entrepreneurship**

<table>
<thead>
<tr>
<th>Title</th>
<th>W 2 credits</th>
<th>V 2 credits</th>
<th>U. Claesson, B. Clarysse</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding. This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.</td>
<td></td>
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<tr>
<td><strong>Objective</strong></td>
<td>This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.</td>
<td></td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>See course website: <a href="http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html">http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html</a></td>
<td></td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Lecture slides and case material</td>
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</table>

**376-0221-00L Methods and Concepts in Human Systems Neuroscience and Motor Control**

<table>
<thead>
<tr>
<th>Title</th>
<th>W 3 credits</th>
<th>P 3 credits</th>
<th>N. Wenderoth</th>
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<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>This course provides hands-on experience with measurement and analysis methods relevant for Humans Systems Neuroscience and Motor control (nerve/brain stimulation, EMG, EEG, psycho-physical paradigms etc). Students read scientific material, set up experiments, perform measurements in the lab, analyse data, apply statistics and write short reports or essays.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>This course will prepare students for experimental work as it is typically done during the master thesis. The goal is to gain hands-on experience with measurement and analysis methods relevant for Humans Systems Neuroscience and Motor control (for example peripheral nerve stimulation, electrical and magnetic brain stimulation, EMG, EEG, psycho-physical paradigms etc). Students will learn how to perform small scientific projects in this area. Students will work individually or in small groups and solve scientific problems which require them to perform measurements in human participants, extract relevant readouts from the data, apply appropriate statistics and interpret the results. They will also be required to write small essays and reports and they will get feedback on their writing throughout the course.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Students are required to have successfully completed the course &quot;Neural control of movement and motor learning&quot; and to have basic knowledge of applied statistics. Self-study material about applied statistics will be available at the beginning of the course and statistical knowledge will be tested (central element) in the second course week. Passing this test is a requirement for continuing the course. Students will have to solve scientific problems, requiring them to independently study scientific material, apply statistics and report their results in the form of written reports and essays. Assessments will be made on the basis of the completed theoretical and practical work that will be performed either in small groups or individually.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Introduction to Physical Activity for Health, including sedentary behavior, physical activity assessment, physical activity policies, physical activity and all cause morbidity and mortality, physical activity and associated diseases, physical activity and associated diseases, physical activity and associated diseases, physical activity and associated diseases.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Selective journal articles from relevant journals such as Journal of Physical Activity and Health and Journal of Aging and Physical Activity are required.</td>
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</table>

**376-0225-00L Physical Activities and Health**

<table>
<thead>
<tr>
<th>Title</th>
<th>W 3 credits</th>
<th>V 2 credits</th>
<th>E. de Bruin</th>
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</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>This course introduces/explres the complex relationship between physical activity, sedentary behavior and health. It will discuss the evolution of current physical activity recommendations. It will examine the current evidence base that has informed physical activity recommendations and that identified physical activity as a key modifiable lifestyle factor contributing to disease and mortality.</td>
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</tbody>
</table>
| **Objective** | On completion of this course students will be able to demonstrate: 1. knowledge of and critical awareness of the role of physical activity and sedentary behaviour in the maintenance of health and the aetiology, prevention and treatment of disease. 2. thorough knowledge and critical awareness of current recommendations for physical activity, and current prevalence and trends of physical activity and associated diseases.
3. awareness of current national and international physical activity policies and how these impact on global challenges. |
| **Content** | Physical activity and all cause morbidity and mortality Physical activity and chronic disease; Coronary heart disease, diabetes, bone health, cancer and obesity Physical activity and brain health Physical activity and sedentary behavior recommendations Population prevalence of physical activity and sedentary behavior Physical activity policies Physical activity assessment |
| **Prerequisites / notice** | Selective journal articles from relevant journals such as Journal of Physical Activity and Health and Journal of Aging and Physical Activity are required. |

**376-1033-00L History of Sports**

<table>
<thead>
<tr>
<th>Title</th>
<th>W 2 credits</th>
<th>V 2 credits</th>
<th>M. Gisler</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Comprehension for development and changes of sports from the ancient world to the presence. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Content</strong></td>
<td>Ein Skript für die aktuelle Veranstaltung wird abgegeben. Literaturangaben für eine Vertiefung der Inhalte werden im Skript gemacht. Die Anschaffung von Spezialliteratur ist allerdings nicht notwendig.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Ein Skript für die aktuelle Veranstaltung wird abgegeben. Literaturangaben für eine Vertiefung der Inhalte werden im Skript gemacht. Die Anschaffung von Spezialliteratur ist allerdings nicht notwendig.</td>
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</tbody>
</table>

**376-1107-00L Sport Pedagogy**

<table>
<thead>
<tr>
<th>Title</th>
<th>W 2 credits</th>
<th>V 2 credits</th>
<th>D. Seiler Hubler</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.</td>
<td></td>
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<tr>
<td><strong>Objective</strong></td>
<td>To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.</td>
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</tbody>
</table>
### 376-1117-00L Sport Psychology

**Objective**
Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students’ expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

**Prerequisites / notice**
None. Bring something to write and your student ID

**Auxiliary tools:**
- Computer
- Internet

**Literature**

A detailed program with additional references will be delivered at the beginning of the lecture.

---

### 376-1127-00L Sociology of Sport

**Objective**
These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.

**Content**
- Introduction to sport psychology
- Cognitions in sports: mental rehearsal and mental training
- Emotions and stress
- Motivation: goal-setting in sports
- Career and career transition in elite sport
- Coach-Athlete-Interaction
- Psychological aspects of sport-injury rehabilitation
- Group dynamics in sport

**Literature**


---

### 376-1155-00L The Musculoskeletal System and Work

**Objective**
Goal of the course is the activation of physiological and patho-physiological insights for the understanding of loads of the musculoskeletal system during work. Prevention and rehabilitation of work related musculoskeletal disease will be discussed with the help of a bio-psycho-social model. Furthermore, evidence based methods for a healthy work design will be presented.

**Content**
- Insights of human movement sciences concerning wear, overstraining and regeneration of the musculoskeletal system form an important base for an ergonomic work design. The following topics will be covered: Muscle fatigue during an 8-hour-day, use of the computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.

**Literature**

---

### 376-1305-00L Development of the Nervous System

**Objective**
The course covers the development of the nervous system (NS) with a focus on neurogenesis and migration, axon growth, synapse formation, mol. & cell. mechanisms, and diseases of the developing NS.

**Content**
The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

**Literature**
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

---

### 376-1305-01L Structure, Plasticity and Repair of the Nervous System

**Objective**
The aim is to give a deepened insight on the normal development, of the nervous system based on molecular, cellular and biochemical approaches.

**Content**
The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

**Auxiliary tools:**
- None. Bring something to write and your student ID
The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromyographical data using the MATLAB computing environment.

During the lecture, several electronically available MATLAB introductions are indicated. Course-specific scripts will be provided by the lecturer.

The combining of training and coaching as in the example of sport analysis, which has an effect on youth training and athlete development.

The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

Students will learn to import, process and graphically present experimental data using the MATLAB computing environment. Both the data and the methods of analysis will be typical for experiments in Human Movement Science (i.e. kinematics, kinetics and electromyography).

The members are able to transform the knowledge from the previous courses in practical situations of Sports and Exercise Therapy. They learn basic aspects to design therapy lessons.

The objective is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.
Knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport.

The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; trainability/exercise physiology and spinal cord injury; history and organisation of wheelchair sports; elite sport and spinal cord injury

Abstract

Intensity dedication concerning complications of a spinal cord injury and their consequences on trainability and exercise performance of persons sitting in a wheelchair. Overview on the clinical application of exercise testing as well as on the implementation of sport scientific findings to optimise performance of spinal cord injured subjects in rehabilitation and elite sports.

Objective

Knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport.

Content

- Physiological, physical, and cognitive factors in sensation and perception
- Basics of Exercise Therapy
- Literature

General literature:

G.A. Zäch, H. G. Koch
Paraplegie - ganzheitliche Rehabilitation
Karger-Verlag, 2006
ISBN 3-8055-7980-2

V. Goosney-Tolfrey
Wheelchair sport: A complete guide for athletes, coaches and teachers
Human Kinetics, 2010

Y.C. Vanlandewijck, W.R. Thompson
The Paralympic Athlete
Wiley-Blackwell, 2011
ISBN 978-1-4443-3404-3

Liz Broad
Sports Nutrition for Paralympic Athletes
CRC Press 2014

Prerequisites / notice

Voraussetzung: Vorlesung Anatomie/Physiologie besucht!

<table>
<thead>
<tr>
<th>Module</th>
<th>Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructors</th>
</tr>
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<tbody>
<tr>
<td>376-1177-00L</td>
<td>Human Factors I</td>
<td>2</td>
<td>2V</td>
<td>M. Menozzi Jäckli, R. Huang, M. Siegrist</td>
</tr>
<tr>
<td>376-1179-00L</td>
<td>Applications of Cybernetics in Ergonomics</td>
<td>1</td>
<td>1U</td>
<td>M. Menozzi Jäckli, Y.Y. Hedinger Huang, R. Huang</td>
</tr>
<tr>
<td>376-1716-00L</td>
<td>Basics of Exercise Therapy</td>
<td>2</td>
<td>2V</td>
<td>K. Marschall</td>
</tr>
</tbody>
</table>

Abstract

Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective

- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry, Digital Human Models
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Content

- Human performance in optimization of production lines
- Cross-link models in neurobiology- the ocular motor control system
- Accommodation/vergence crosslink function
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature

- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students
- Further textbooks are introduced in the lecture
- Bouchreous, checklists, key articles etc. are uploaded in ILIAS

Abstract

Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involving the performance in multi-model interactions, quantification in gestalt principles in product development; or the information processing matter.

Objective

To learn and practice cybernetics principles in interface designs and product development.

Content

- Fitt's law applied in manipulation tasks
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection
- Accommodation/vergence crosslink function
- Cross-link models in neurobiology- the ocular motor control system
- Human performance in optimization of production lines

Literature

Dietary Etiologies of Chronic Disease

Elmadfa I & Leitzmann C: Ernährung des Menschen
Schüle / Huber: Grundlagen der Sporttherapie, Deutscher Ärzteverlag, Köln 2012
Deimel et al.: Neue aktive Wege in Prävention und Rehabilitation, Deutscher Ärzteverlag, Köln 2007

The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease and its causes, to the development of preventive and treatment interventions and to improved population health.

The module Public Health Concepts offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

The lecture notes are made available on-line to students.

Handouts will be made available.

Public Health Concepts

The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease and its causes, to the development of preventive and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples from nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

Public Health Concepts

The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

The lecture notes are available to students in the classroom.

Language of the course is English.

Public Health Concepts

The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease and its causes, to the development of preventive and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples from nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

Public Health Concepts

The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

The lecture notes are available to students in the classroom.

Language of the course is English.
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Lecture notes
Lecture slides and required handouts will be available on the ETH website.

Literature
Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

Prerequisites / notice
General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

15 credits

Practical Training II

3-months practical work with topics from the major exercise in movement and training doctrines.

Lecturers
E. de Bruin

15 credits

Practical Training I

3-months practical work with topics from the major exercise in movement and training doctrines.

Lecturers
E. de Bruin

Master’s Thesis

6-months research study with topics from the major exercise in movement and training doctrines.

Lecturers
E. de Bruin

Major in Biomechanics

Compulsory Subjects

Clinical and Movement Biomechanics

Measurement and modeling of the human movement during daily activities and in a clinical environment.

Lecturers
S. Lorenzetti, R. List, N. Singh

Dynamics

Kinematics, dynamics and oscillations: Motion of a single particle - Motion of systems of particles - 2D and 3D motion of rigid bodies

Lecturers
G. Halier, P. Tiso
This course provides Bachelor students of mechanical engineering with fundamental knowledge of kinematics and dynamics of mechanical systems. By studying motion of a single particle, systems of particles and rigid bodies, we introduce essential concepts such as work and energy, equations of motion, and forces and torques. Further topics include stability of equilibria and vibrations. Examples presented in the lectures and weekly exercise lessons help students learn basic techniques that are necessary for advanced courses and work on engineering applications.

1. Motion of a single particle
   - Kinematics: trajectory, velocity, acceleration, inertial frame, moving frames - Forces and torques. Active- and reaction forces. - Linear momentum principle, angular momentum principle, work-energy principle - Equations of motion;
2. Motion of systems of particles
   - Internal and external forces - Linear momentum principle, angular momentum principle, work-energy principle - Rigid body systems of particles; conservative systems
3. 3D motion of rigid bodies
   - Kinematics: angular velocity, velocity transport formula, instantaneous center of rotation - Linear momentum principle, angular momentum principle, work-energy principle - Parallel axis theorem. Angular momentum transport formula
4. Vibrations

Hand-written slides will be downloadable after each lecture.

Please log in to moodle (https://moodle.app2.let.ethz.ch/auth/shibboleth/login.php), search for "Dynamics", and join the course there. All exercises sheets, lecture materials etc. will be uploaded there.

Lecture notes
Hand-written slides from the previous year

Literature
Typed course notes from the previous year

Prerequisites / notice
Please log in to moodle (https://moodle.app2.let.ethz.ch/auth/shibboleth/login.php), search for "Dynamics", and join the course there. All exercises sheets, lecture materials etc. will be uploaded there.

227-0385-10L Biomedical Imaging W 6 credits 5G S. Kozerke, K. P. Prüsmann, M. Rudin

Abstract
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes
Lecture notes and handouts

Literature
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Prerequisites / notice
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

227-0386-00L Biomedical Engineering W 4 credits 3G J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong

Abstract
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Objective
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Content

Lecture notes
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

Prerequisites / notice

227-0447-00L Image Analysis and Computer Vision W 6 credits 3V+1U L. Van Gool, O. Göksel, E. Konukoglu

Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material, Script, computer demonstrations, exercises and problem solutions

Prerequisites / notice
Prerequisites:
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.

227-1051-00L Systems Neuroscience (University of Zurich) W 6 credits 2V+1U D. Kiper

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: INI415

The course language is English.
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
This course focuses on basic aspects of central nervous system physiology, including perception, motor control and cognitive functions.

Objective
To understand the basic concepts underlying perceptual, motor and cognitive functions.

Content
Main emphasis sensory systems, with complements on motor and cognitive functions.

Lecture notes
None

Literature
"Principles of Neural Science", Kandel, Schwartz, and Jessel

Prerequisites / notice
none

363-0790-00L Technology Entrepreneurship

W 2 credits 2V U. Claesson, B. Clarysse

Abstract
Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding. This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

Objective
This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

Content
See course website: http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html

Lecture notes
Lecture slides and case material

376-1219-00L Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions

W 3 credits 2V R. Riener, R. Gassert, L. Marchal Crespo

Abstract
Rehabilitation Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

Content
Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces
Literature

Introductory Books:


Selected Journal Articles and Web Links:


Abstract

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective

The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed. In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Prerequisites / notice

Target Group:
Students of higher semesters and PhD students of:
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

376-1714-00L Biocompatible Materials W 4 credits 3G K. Maniura, J. Möller, M. Zenobi-Wong

Abstract

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective

The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed. In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes

Handouts can be accessed online.
This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact
prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact
loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite
element modelling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real world
examples mainly from automobile safety are used to augment lecture material.

Handouts will be made available.

**Literature**


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### 376-1974-00L

#### Colloquium in Biomechanics

**W 2 credits 2K**

**Objective**

Getting insight into actual areas and problems of biomechanics.

**Abstract**

Current topics in biomechanics presented by speakers from academia and industry.

**Literature**

Handouts provided during the classes and references therein.

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### 376-1985-00L

#### Trauma Biomechanics

**W 4 credits 2V+1U**

**K.U. Schmitt, M. H. Muser**

**Objective**

Introduction to the basic principles of trauma biomechanics.

**Content**

This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact
biomechanics, which uses the combination of fundamental engineering principles and advanced medical technologies to develop injury
prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact
loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite
element modelling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real world
examples mainly from automobile safety are used to augment lecture material.

Handouts will be made available.

**Literature**


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### 376-2017-00L

#### Biomechanics of Sports Injuries and Rehabilitation

**W 3 credits 2V**

**K.U. Schmitt, J. Goldhahn**

**Objective**

Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to
know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess
the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

**Content**

This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented.
Furthermore possibilities to prevent injuries are discussed. Thereby the lecture focuses on sports injuries.

Handouts will be made available.

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### 401-0625-01L

#### Applied Analysis of Variance and Experimental Design

**W 5 credits 2V+1U**

**L. Meier**

**Objective**

square designs. Split-plot and strip-plot designs. Random effects and mixed effects models. Full factorials and fractional designs.

**Content**

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by
using the software R.

---

### 551-1295-00L

#### Introduction to Bioinformatics: Concepts and Applications

**W 6 credits 4G**

**W. Gruissem, K. Bärenfaller, A. Callfisch, G. Capitani, J. Fütterer, M. Robinson, A. Wagner**

**Objective**

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a
number of applications in bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in
theory and praxis.

**Content**

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background
of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be
used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used
for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene
expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps
and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical exercises, the students will develop hands-on experiences with the bioinformatics methods through guided
exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on
biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and
computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important
foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be
offered in the following semester.

**Applications**

From genes to databases and information BLAST searches Prediction of gene function and regulation RNA structure prediction Gene
expression analysis using microarrays Protein sequence and structure databases WWW for bioinformatics Protein sequence comparisons
Proteomics and de novo protein sequencing Protein structure prediction Cellular and protein interaction networks Molecular dynamics simulation
Practical Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-2010-00L</td>
<td>Practical Training I</td>
<td>O</td>
<td>15 credits</td>
<td>15P</td>
<td>S. Lorenzetti</td>
</tr>
<tr>
<td>Abstract</td>
<td>3-months practical work with topics from the major exercise biomechanics.</td>
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<tr>
<td>Objective</td>
<td>3-months practical work with topics from the major exercise biomechanics.</td>
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</table>

| 557-2011-00L | Practical Training II | O    | 15 credits | 15P   | S. Lorenzetti     |
| Abstract  | 3-months practical work with topics from the major exercise biomechanics. |
| Objective | 3-months practical work with topics from the major exercise biomechanics. |

Master’s Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-2100-00L</td>
<td>Master’s Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>30D</td>
<td>B. Taylor</td>
</tr>
<tr>
<td>Abstract</td>
<td>Only students who fulfill the following criteria are allowed to begin with their master thesis: a. successful completion of the bachelor programme; b. fulfilling of any additional requirements necessary to gain admission to the master programme.</td>
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<tr>
<td>Objective</td>
<td>The thesis is the final work of the Master program. It promotes the students abilities to develop and solve a research problem independently, structured under methodological considerations. The thesis is based on the studies of Bachelor program and the lectures of the Master Program.</td>
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Major in Sport Physiology

Electives

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<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6 credits</td>
<td>5G</td>
<td>M. Zenobi-Wong</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.</td>
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<tr>
<td>Objective</td>
<td>To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.</td>
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<tr>
<td>Content</td>
<td>- X-ray imaging</td>
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<td></td>
<td>- Computed tomography</td>
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<td>- Single photon emission tomography</td>
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<td></td>
<td>- Positron emission tomography</td>
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<td></td>
<td>- Magnetic resonance imaging</td>
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<td></td>
<td>- Ultrasound/Doppler imaging</td>
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<tr>
<td>Literature</td>
<td>Lecture notes and handouts</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011 Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming</td>
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</table>

| 227-0386-00L | Biomedical Engineering | W    | 4 credits | 3G    | J. Váracs, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong |
| Abstract  | Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined. |
| Objective | Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations. |
| Lecture notes | Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino |
|             | https://www1.ethz.ch/lbb/Education/BME |

| 227-1051-00L | Systems Neuroscience (University of Zurich) | W    | 6 credits | 2V+1U | D. Kiper         |
| Abstract  | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: INI415 |
| Objective | Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html |
| Content   | This course focuses on basic aspects of central nervous system physiology, including perception, motor control and cognitive functions. |
| Lecture notes | None |

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: INI415

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

This course focuses on basic aspects of central nervous system physiology, including perception, motor control and cognitive functions.

Main emphasis sensory systems, with complements on motor and cognitive functions.
**363-0301-00L Work Design and Organizational Change**

- **Objective**: Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.
- **Content**: - Know effects of work design on competence, motivation, and well-being - Understand links between design of individual jobs and work processes - Know basic processes involved in systematic organizational change - Understand the interaction between organization and technology and its impact on organizational change - Understand relevance of work design for company performance and strategy - Know and apply methods for analyzing and designing work

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<tr>
<th>Lecture notes</th>
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<tbody>
<tr>
<td>Literature</td>
<td>A list of required readings will be provided at the beginning of the course.</td>
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<table>
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<tr>
<th>Prerequisites / notice</th>
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</table>

**363-0790-00L Technology Entrepreneurship**

- **Objective**: Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding. This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.
- **Content**: See course website: http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature</td>
<td>The course includes the completion of a course project to be conducted in groups of four students. The project entails applying a particular method for analyzing and designing work processes and is carried out by means of interviews and observations in companies chosen by the students.</td>
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</tbody>
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<tr>
<th>Prerequisites / notice</th>
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</table>

**376-0130-00L Laboratory Course in Exercise Physiology**

- **Objective**: Conduct physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that deepen the understanding of physiological processes in response to physical exertion.
- **Content**: Various exercise tests assessing human performance and assessments of physiological responses to activity (examples are VO2max-test, Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test), dynamometry, mechanography, body composition etc.). Insight into measurements in Sports Medicine.

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature</td>
<td>Tutorial on Laboratory Experiments in Exercise Physiology (Editor: Exercise Physiology Lab)</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Prerequisite: Anatomy and physiology classes and lab course in physiology successfully completed (BWS students please contact C. M. Spengler)</td>
</tr>
<tr>
<td>Desirable:</td>
<td>Exercise Physiology Lecture (concomitantly or passed; is selection criterion in case of more applications than lab spaces)</td>
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<tr>
<th>Prerequisites / notice</th>
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**376-0221-00L Methods and Concepts in Human Systems Neuroscience and Motor Control**

- **Objective**: This course provides hands-on experience with measurement and analysis methods relevant for Humans Systems Neuroscience and Motor control (nerve/brain stimulation, EMG, EEG, psycho-physical paradigms etc). Students read scientific material, set up experiments, perform measurements in the lab, analyse data, apply statistics and write short reports or essays.

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature</td>
<td>This course requires students to have successfully completed the course &quot;Neural control of movement and motor learning&quot; and to have basic knowledge of applied statistics. Self-study material about applied statistics will be available at the beginning of the course.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students are required to have successfully completed the course &quot;Neural control of movement and motor learning&quot; and to have basic knowledge of applied statistics. Self-study material about applied statistics will be available at the beginning of the course.</td>
</tr>
</tbody>
</table>

**376-0225-00L Physical Activities and Health**

- **Objective**: Conduct physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature</td>
<td>Physicians, and patients and that</td>
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</table>

<table>
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<tr>
<th>Prerequisites / notice</th>
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</table>

**Data: 06.11.2018 12:57 Autumn Semester 2016 Page 201 of 1571**
This course introduces/explores the complex relationship between physical activity, sedentary behavior and health. It will discuss the evolution of current physical activity recommendations. It will examine the current evidence base that has informed physical activity recommendations and that identified physical activity as a key modifiable lifestyle behavior contributing to disease and mortality.

On completion of this course, students will be able to demonstrate:
1. knowledge of and critical awareness of the role of physical activity and sedentary behavior in the maintenance of health and the etiology, prevention and treatment of disease.
2. thorough knowledge and critical awareness of current recommendations for physical activity, and current prevalence and trends of physical activity and associated diseases.
3. awareness of current national and international physical activity policies and how these impact on global challenges.

Introduction to Physical Activity for Health, including sedentary behavior
Physical activity epidemiology; concepts and principles and approaches
Physical activity and all cause morbidity and mortality
Physical activity and chronic disease; Coronary heart disease, diabetes, bone health, cancer and obesity
Physical activity and brain health
Physical activity and sedentary behavior recommendations
Population prevalence of physical activity and sedentary behavior
Physical activity policies
Physical activity assessment

Core texts for this course are:

Selective journal articles from relevant journals such as Journal of Physical Activity and Health and Journal of Aging and Physical Activity are included in the course material.

<table>
<thead>
<tr>
<th>376-1033-00L</th>
<th>History of Sports</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>M. Gisler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Comprehension for development and changes of sports from the ancient world to the presence. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.</td>
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<tr>
<td>Lecture notes</td>
<td>Ein Skript für die aktuelle Veranstaltung wird abgegeben.</td>
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</table>

<table>
<thead>
<tr>
<th>376-1107-00L</th>
<th>Sport Pedagogy</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>D. Seiler Hubler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.</td>
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<tr>
<td>Content</td>
<td>Inhaltliche Schwerpunkte der Vorlesung sind:</td>
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</tbody>
</table>
- Einführung in die Sportpädagogik und die pädagogische Psychologie des Sportunterrichts
- Bedeutung des Sports im Jugendalter
- Zeitgemäßer Sportunterricht
- Sport und Leistung
- Heterogenität im Sportunterricht
- Sport und Gesundheit
- Geschlechterfragen im Sport
- Soziale und moralische Entwicklung im Sportunterricht |
| Lecture notes| Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt. |

<table>
<thead>
<tr>
<th>376-1117-00L</th>
<th>Sport Psychology</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>H. Gubelmann</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.</td>
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<tr>
<td>Content</td>
<td>Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students’ expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.</td>
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</table>

<table>
<thead>
<tr>
<th>376-1127-00L</th>
<th>Sociology of Sport</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>M. Lamprecht</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>The lectures set out to:</td>
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</tbody>
</table>
- present the different dimensions, functions and interrelationships of present-day sport |
- provide an introduction to the central theories and models of (sport) sociology |
- show how far sport reflects society and how it changes and becomes more differentiated in the process |
- take current examples from newspapers, magazines and television to highlight the sociological view of sport. |

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Content
- Sport and social change: developments and trends
- The economy and the media: dependencies, consequences, scandals
- Social inequalities and distinctions: gender differences and group behavior
- Conflicts and politics: sports organizations, doping, violence

Lecture notes
- Selected materials for the lecture are available under www.LSSFB.ch --> Lehre

A detailed program with additional references will be delivered at the beginning of the lecture.

376-1155-00L
The Musculoskeletal System and Work
W 3 credits 2V T. Läubli

Abstract
Consolidated findings of movement sciences concerning deterioration, overload and regeneration of the musculoskeletal system are an important basis for an ergonomic working environment. The following topics are covered: Muscle fatigue during the 8-hour day, use of the computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.

Objective
Goal of the course is the activation of physiological and patho-physiological insights for the understanding of loads of the musculoskeletal system during work. Prevention and measures related to work related musculoskeletal disease will be discussed with the help of a bio-psycho-social model. Furthermore, evidence based methods for a healthy work design will be presented.

Content
- Insights of human movement sciences concerning wear, overstraining and regeneration of the musculoskeletal system form an important base for an ergonomic work design. The following topics will be covered: Muscle fatigue in an 8-hours-day, mouse appliance, back pain, insertion tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, and measurement methods.

Literature
- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students.

376-1177-00L
Human Factors I
W 2 credits 2V M. Menozzi Jäckli, R. Huang, M. Siegrist

Abstract
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective
The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthrometry, Digital Human Models
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in systems design, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature
- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students.
- Further textbooks are introduced in the lecture
- Brouchures, checklists, key articles etc. are uploaded in ILIAS

376-1179-00L
Applications of Cybernetics in Ergonomics
W 1 credit 1U M. Menozzi Jäckli, Y.Y. Hedinger Huang, R. Huang

Abstract
Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involves the performance in multi-model interactions, quantification in gestalt principles in product development; or the information processing matter.

Objective
To learn and practice cybernetics principles in interface designs and product development.

Content
- Fitt's law applied in manipulation tasks
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection
- Accommodation/vergence crosslink function
- Cross-link models in neurobiology- the ocular motor control system
- Human performance in optimization of production lines

Literature

376-1305-00L
Development of the Nervous System
W 3 credits 2V E. Stoecckli, further lecturers

Abstract
The course covers the development of the nervous system (NS) with a focus on neurogenesis and migration, axon growth, synapse formation, mol. & cell. mechanisms, and diseases of the developing NS.

Objective
The aim is to give a deepened insight on the normal development, of the nervous system based on molecular, cellular and biochemical approaches.

Content
- The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

Literature
- Must be downloaded from OLAT: https://www.olat.uzh.ch/olat/dmz/as BIO344
- The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.
- Auxiliary tools: None. Bring something to write and your student ID

376-1305-01L
Structure, Plasticity and Repair of the Nervous System
W 3 credits 2V M. E. Schwab, L. Filli, K. A. Martin, further lecturers

Abstract
The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

Objective
The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content
- The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

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Lecture notes

ETH students: Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

UZH students: Lecture notes will be provided on OLAT: https://www.olat.uzh.ch/olat/dmz/
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

376-1655-00L

Training and Coaching I W 3 credits 2G O. Buholzer

Abstract

The combining of training and coaching as in the example of sport analysis, which has an effect on youth training and athlete development.

- To develop basics for a differentiate analyses of sports (model)
- To develop a profile of requirements for specific sports
- To develop competencies of training with youth and talents
- To develop the basics of talent training in theory and practice
- To observe athletes in case studies, make judgments and conclusion

Objective

- Das Modell der Sportartenanalyse
- Die Relevanz der einzelnen Leistungsfaktoren
- Das Modell der Wettkampfanalyse
- Folgerungen für das Training und Coaching in der Sportart
- Folgerungen für das Nachwuchs training
- Folgerungen für die Athletenauswahl, Athletenbeobachtung und -betreuung
- Das Nachwuchs- und Talenttraining (Sichtung, Selektion, Förderung)
- Projekte aus der Praxis (Talent- und Nachwuchstraining)
- Praxisinput zum Thema Koordination, motorische Grundbedürfnisse, Kraft und Gesundheit
- Praxisbeispiele erarbeiten und planen
- Konkrete Athletenbeobachtung

Content

Das Modell der Sportartenanalyse
Die Relevanz der einzelnen Leistungsfaktoren
Das Modell der Wettkampfanalyse
Folgerungen für das Training und Coaching in der Sportart
Folgerungen für das Nachwuchs training
Folgerungen für die Athletenauswahl, Athletenbeobachtung und -betreuung
Das Nachwuchs- und Talenttraining (Sichtung, Selektion, Förderung)
Projekte aus der Praxis (Talent- und Nachwuchstraining)
Praxisinput zum Thema Koordination, motorische Grundbedürfnisse, Kraft und Gesundheit
Praxisbeispiele erarbeiten und planen
Konkrete Athletenbeobachtung

Lecture notes

Die Skript- (Lektionsunterlagen) werden im Rahmen des Semesters abgeben und auf Homepage veröffentlicht.

Literature

Leistungsdiaagnostische Verfahren, Stiehler(Konzag/Döbler)
Training fundiert erklärt, Handbuch der Trainingslehre, Ingold Verlag 2006
Das sportliche Talent, W. Joch, Meyer&Meyer Verlag, 2002
Das neue Konditionstraining, Grosser/Starischka/Zimmermann, blv 2002
Struktur sportlicher Leistung (Modellansatz von Gundlach; (Trainingswissenschaften S. 45 - 49; Stiehler(Konzag/Döbler)
Leistungsdiagnostische Verfahren, Stiehler(Konzag/Döbler)

376-1716-00L

Basics of Exercise Therapy W 2 credits 2V K. Marschall

Number of participants limited to 30.
Possible from the 5th semester on.
Requirement:"Introduction of Exercise Therapy" passed.

Abstract

Basics of Exercise Therapy:
A: diagnostic, anamnesis, diagnostic of movement and function, assessments in exercise therapy, diagnostic of experience and behavior in relation to movement
B: biological-medical basics, pathophysiological Basics (internal, orthopedic and psychological deseases.
C: didactic knowledge, Reha-didactic

Objective

Students learn the assessments to plan an exercise-therapy-treatment.
They are able to use them. They're able to integrate biological and medical basics.
They are able to prepare a therapy-session

Content

Grundlagen der Diagnostik, Anamnese, Bewegungsdiagnostik, Funktionsdiagnostik
Sport- und Bewegungstherapeutische Testverfahren
Motorische Basisdiagnostik
Diagnostik bewegungsbezogenen Erlebens und Verhaltens
Biologisch-medicinische Grundlagen
Biomechanik (v.a. Gelenke), Pathophysiologische Grundlagen, Modelle der Methodik und Didaktik, Lektionsplanung

Lecture notes

wird vor Semesterbeginn elektronisch zur Verfügung gestellt

Literature

- Schüle / Huber: Grundlagen der Sporttherapie, Deutscher Ärzteverlag , Köln 2012
- Deimel et al.: Neue aktive Wege in Prävention und Rehabilitation, Deutscher Ärzteverlag, Köln 2007

Prerequisites / notice

lecture "Introduction in Exercise Therapy" ist prerequisite

90% of the lections students must be present.

376-1717-00L

Practical Basics in Sports and Exercise Therapy W 2 credits 2V B. Spörri Kälin, B. Keller

Number of participants limited to 30.
Possible from the 5th semester on.
Requirement:"Introduction of Exercise Therapy" passed.

Abstract

Impart knowledge of practical basics of Sports and Exercise Therapy

Objective

The members are able to transform the knowledge from the previous courses in practical situations of Sports and Exercise Therapy. They learn basic aspects to design therapy lessons.
Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromyographical data using the MATLAB computing environment. Course-specific scripts will be provided by the lecturer. The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; trainability/exercise physiology and spinal cord injury; history and organisation of wheelchair sports; elite sport and spinal cord injury.

**Prerequisites / notice**
A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

**376-1720-00L** Application of MATLAB in the Human Movement Sciences

| Objective | Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromyographical data using the MATLAB computing environment. |
| Content | Drawbacks of Excel; Possibilities in MATLAB; Import of several data formats; Plot of one and more signals; Removing of an offset and filtering of data based on self-written functions; Normalisation and parametrisation of data; Reliability; Interpolation, Differentiation and Integration in MATLAB. |
| Literature | During the lecture, several electronically available MATLAB introductions are indicated. Course-specific scripts will be provided by the lecturer. |
| Prerequisites / notice | A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free. |

**376-1722-00L** Spinal Cord Injury and Exercise

| Objective | Knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport. |
| Content | The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; trainability/exercise physiology and spinal cord injury; history and organisation of wheelchair sports; elite sport and spinal cord injury. |
| Prerequisites / notice | Voraussetzung: Vorlesung Anatomie/Physiologie besucht! |

**376-2017-00L** Biomechanics of Sports Injuries and Rehabilitation

| Objective | This lecture deals with the basic principles of injury mechanics and rehabilitation focussing on sports injuries. Furthermore, possibilities to prevent injuries are discussed. Theoretical aspects will be highlighted. |
| Content | This lecture introduces the basic principles of impact mechanics, bioavailability, metabolism and excretion with some focus on energy metabolism. |
| Lecture notes | Handouts will be made available. |
| Prerequisites / notice | A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture. |

**752-6001-00L** Introduction to Nutritional Science

| Objective | To introduce the students to the basic concepts of micro- and macronutrient nutrition. Macronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism. |
| Content | The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to diet, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized. |
| Lecture notes | There is no script. Powerpoint presentations will be made available. |

**752-6101-00L** Dietary Etiologies of Chronic Disease

| Objective | There is no script. Powerpoint presentations will be made available. |
| Content | There is no script. Powerpoint presentations will be made available. |
| Literature | There is no script. Powerpoint presentations will be made available. |
| Prerequisites / notice | There is no script. Powerpoint presentations will be made available. |
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

There is no script. Powerpoint presentations will be made available on-line to students.

To be provided by the individual lecturers, at their discretion.

No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.
Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

Practical Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>557-3010-00L</td>
<td>Practical Training I</td>
<td>O</td>
<td>15 credits</td>
<td>15P</td>
<td>C. Spengler</td>
</tr>
<tr>
<td>Abstract</td>
<td>3-months practical experience with topics from the major exercise physiology.</td>
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<tr>
<td>Objective</td>
<td>The students should obtain practical experience of 3 month length in possible job environments. The selected places (internal or external) should be as close as possible by the major exercise physiology.</td>
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<tr>
<td>Content</td>
<td>The content of the practica is determined by the supervisor together with the student.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Practica can be combined with the master thesis. In such a case, it can only be started after the Bachelor Degree was obtained and the Vertiefungsleiter has approved the study.</td>
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<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>557-3011-00L</td>
<td>Practical Training II</td>
<td>O</td>
<td>15 credits</td>
<td>15P</td>
<td>C. Spengler</td>
</tr>
<tr>
<td>Abstract</td>
<td>3-months practical work with topics from the major exercise physiology.</td>
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<tr>
<td>Objective</td>
<td>The students should obtain practical experience of 3 month length in possible job environments. The selected places (internal or external) should be as close as possible by the major exercise physiology.</td>
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<tr>
<td>Content</td>
<td>The content of the practical work is determined by the supervisor together with the student.</td>
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<tr>
<td>Prerequisites / notice</td>
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Master's Thesis

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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>557-3100-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>30D</td>
<td>C. Spengler</td>
</tr>
<tr>
<td>Abstract</td>
<td>6-months research study with topics from the major exercise physiology.</td>
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<tr>
<td>Objective</td>
<td>The student shall apply his basic knowledge in a practical scientific study. He/she will be confronted with the requirements of scientific working. He/she must master these requirements.</td>
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<tr>
<td>Content</td>
<td>The content of the master thesis is determined by the supervisor together with the student. The thesis can begin only after the approval Vertiefungsleiter.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The master thesis can only be started after the Bachelor Degree was obtained and the Vertiefungsleiter has approved the study.</td>
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Sport Practical
For the entire offering see Sport Teaching Diploma.

see Sport Teaching Diploma, Sport Practical: Basic Education

see Sport Teaching Diploma, Sport Practical: Major Education

see Sport Teaching Diploma, Sport Practical: Education acquired outside ETH

GESS Science in Perspective
Recommended GESS Science in Perspective (Type B) for D-HEST.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Human Movement Sciences Master - Key for Type

<table>
<thead>
<tr>
<th>W+</th>
<th>Eligible for credits and recommended</th>
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<tbody>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>O</td>
<td>Compulsory</td>
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<td>Z</td>
<td>Courses outside the curriculum</td>
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</table>
### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Biology (General Courses)

**Complementary Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>Z Dr</td>
<td>4</td>
<td>2V+1U</td>
<td>D. Poulitakos, A. Ferrari</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Theory and application of thermodynamics and energy conversion in</td>
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<td></td>
<td>biological systems with focus on the cellular level.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>Theory and application of energy conversion at the cellular level.</td>
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<td></td>
<td>Understanding of the basic features governing solutes transport in</td>
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<td></td>
<td>the principal systems of the human cell.</td>
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<td>Connection of characteristics and patterns from other fields of</td>
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<td>engineering to biofluidics.</td>
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<td>Heat and mass transport processes in the cell, generation of forces,</td>
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<td></td>
<td>work and relation to biomedical technologies.</td>
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<td><strong>Content</strong></td>
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<td></td>
<td>Mass transfer models for the transport of chemical species in the</td>
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<td>human cell. Organization and function of the cell membrane and of</td>
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<td></td>
<td>the cell cytoskeleton. The role of molecular motors in cellular force</td>
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<td></td>
<td>generation and their function in cell migration. Description of the</td>
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<td></td>
<td>functionality of these systems and of analytical experimental and</td>
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<td>computational techniques for understanding of their operation.</td>
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<td></td>
<td>Introduction to cell metabolism, cellular energy transport and</td>
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<td>cellular thermodynamics.</td>
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<td><strong>Lecture notes</strong></td>
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<td>Material in the form of hand-outs will be distributed.</td>
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<td></td>
<td><strong>Literature</strong></td>
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<td>Lecture notes and references therein.</td>
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<tr>
<td>376-1791-00L</td>
<td>Introductory Course in Neuroscience I (University of Zurich)</td>
<td>Z Dr</td>
<td>2</td>
<td>2V</td>
<td>J.M. Fritschy, W. Knecht</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding</td>
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<td>module directly at UZH.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>The course gives an introduction to human and comparative</td>
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<td></td>
<td>neuroanatomy, molecular, cellular and systems neuroscience.</td>
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<td><strong>Content</strong></td>
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<td>1) Human Neuroanatomy I&amp;II</td>
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<td>2) Comparative Neuroanatomy</td>
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<td>3) Development I&amp;II</td>
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<td>4) Membran and Action Potential</td>
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<td>5) Synaptic Transmission &amp; Plasticity I&amp;II</td>
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<td>6) Glia and Blood-Brain-BARRIER</td>
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<td>7) Somatosensory and Motor System</td>
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<td>8) Visual System</td>
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<td>9) Auditory System</td>
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<td>10) Circuits underlying Emotion</td>
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<td>11) Modeling of Neural Circuits</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>For doctoral students of the Neuroscience Center Zurich (ZNZ).</td>
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<tr>
<td>376-1795-00L</td>
<td>Advanced Course in Neurobiology I (Functional Anatomy of the Rodent</td>
<td>Z Dr</td>
<td>2</td>
<td>2V</td>
<td>J.M. Fritschy, H. U. Zeilhofer</td>
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<td>Brain) (University of Zurich)</td>
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<td><strong>Abstract</strong></td>
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<td>No enrolment to this course at ETH Zurich. Book the corresponding</td>
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<td>module directly at UZH.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>The goal of this Advanced Course in Neurobiology is to provide</td>
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<td>students with a broader perspective of important areas of</td>
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<td></td>
<td>neurobiology. The course consists of four parts: Part I deals with</td>
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<td></td>
<td>various topics in developmental neurobiology. Part II is devoted to</td>
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<td>aspects of signal transduction. Part III focuses on synaptic</td>
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<td>transmission. Part IV gives deeper insights into systems</td>
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<td>neuroscience.</td>
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<td></td>
<td>Für Doktorierende des Zentrums für Neurowissenschaften Zürich. Nicht</td>
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<td>für Master-Studierende geeignet.</td>
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<tr>
<td>551-1159-00L</td>
<td>Molecular Systems Biology</td>
<td>Z Dr</td>
<td>0</td>
<td>1K</td>
<td>U. Sauer, R. Aebersold</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>Seminar series on current research topics in systems biology</td>
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<td>An overview of system biology research</td>
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<td><strong>Objective</strong></td>
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<td>Seminar series on current research topics in systems biology</td>
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<td>701-0265-00L</td>
<td>Ecology and Evolution</td>
<td>Z Dr</td>
<td>1</td>
<td>2S</td>
<td>E. Postma, J. Jokela</td>
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<td><strong>Abstract</strong></td>
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<td></td>
<td>Enrolment to this course unit only possible at ETH. No enrolment to</td>
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<td>Please mind the ETH enrolment deadlines for UZH students:</td>
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<td><a href="https://www.ethz.ch/en/studies/non-degree-courses/special-students/">https://www.ethz.ch/en/studies/non-degree-courses/special-students/</a></td>
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<td>special-students-university-of-zurich.html</td>
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<td><strong>Objective</strong></td>
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<td>A course dedicated to the reading and discussion of the relevant</td>
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<td></td>
<td>literature. The actual list of theme papers will be proposed anew</td>
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<td>for every year. Students then choose a topic and prepare themselves</td>
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<td>for a general discussion with their colleagues and peers. In the</td>
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<td>process, current and controversial topics will be discussed and</td>
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<td><strong>Content</strong></td>
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<td></td>
<td>All topics focus on themes from ecology and evolution, notably</td>
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<td>so on studies on adaptation of organisms, their evolutionary</td>
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<td>history, or on questions of current methodology.</td>
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<td><strong>Lecture notes</strong></td>
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</table>
The actual content, i.e. the theme papers, will be determined and allocated to the participants at the start of the course each year. 

Takes place at Uni Irchel. Please refer to notes on board or ask secretary Mrs. Rita Jenny (Rita.Jenny@env.ethz.ch).

Requirements: Knowledge of ecology and evolution, e.g., lectures during basic and advanced study period. The course is meant for advanced and PhD students.

151-0927-00L
Rate-Controlled Separations in Fine Chemistry
Z Dr 4 credits 3G M. Mazzotti

Abstract
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Objective
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Content
The class covers separation techniques that are central in the purification and downstream processing of chemicals and bio-pharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

Lecture notes
Handouts during the class

Literature
Recommendations for textbooks will be covered in the class

Prerequisites / notice
Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

401-0649-00L
Applied Statistical Regression
Z Dr 5 credits 2V+1U M. Dettling

Abstract
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student’s own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content
The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models; this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

Lecture notes
A script will be available.

Literature
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L “Applied Statistical Regression” and 401-3622-00L “Regression” are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

551-1615-00L
NMR Methods for Studies of Biological Macromolecules
Z Dr 1 credit 1S G. Wider

Prerequisites: Basic knowledge in biological NMR spectroscopy.

Abstract
Seminar series on technical aspects of high resolution nuclear magnetic resonance (NMR) spectroscopy with biological macromolecules.

Objective
Introduction and advanced methods for recording and analysis of NMR data with biological macromolecules.

Content
Seminar series on technical aspects of high-resolution nuclear magnetic resonance (NMR) spectroscopy with biological macromolecules.

551-1619-00L
Structural Biology
Z Dr 1 credit 1K R. Glockshuber, F. Allain, N. Ban, K. Locher, E. Weber-Ban, G. Wider, K. Wüthrich

Abstract
The course consists of a series of research seminars on Structural Biology, Biochemistry and Biophysics, given by both scientists of the National Center of Competence in Research (NCCR) in Structural Biology and external speakers. Information on the individual seminars is provided on the following websites: http://www.structuralbiology.uzh.ch/educ002.asp http://www.bioli.ethz.ch/dbiol-cal/index

Objective
The goal of this course is to provide doctoral and postdoctoral students with a broad overview on the most recent developments in biochemistry, structural biology and biophysics.

851-0180-00L
Research Ethics
Z Dr 2 credits 2G G. Achermann

Particularly suitable for students of D-BIOL, D-CHAB, D-HEST

Abstract
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective
The main goal of this course is to enhance the student’s ability to: - recognize and identify ethical issues and conflicts, - analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry
---------------------------------------
Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)
----------------------------------------------------------
Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access;
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

376-1581-00L Cancer: Fundamentals, Origin and Therapy
Z 2 credits 2G H. Nägeli
Students are able to describe selected chemicals, biological and molecular processes that occur in cells spontaneously or after physical or chemical exposure and resulting in a tumor. They are able to list important cancer-inducing agents and explain the respective mechanism of action. They have knowledge of significant risk factors for cancer diseases. They are confronted with the basics of toxicology and they can explain the principle of the most common therapeutic strategies.

The lecture deals with problems of tumor epidemiology (causes, mortality, incidence). Cancer is delineated as a multi-step process. Classes of chemical compounds that induce cancer are discussed as well as the reactive metabolites that may be built from. Covalent binding to DNA is discussed and different types of mutations resulting thereof. A selection of proto-oncogenes and tumor suppressor genes is presented. Their function will be discussed as well as the changes which are found in these genes in tumor cells, starting from single nucleotide exchanges up to large deletions. The reason for genetic predisposition to cancer will be discussed as well as cancer relevant aspects of cell cycle regulation. Phenomenons like angiogenesis and metastasis are presented as well as the mechanisms that protect the genome from mutagenic damage. Further subjects address old and new strategies of cancer treatment. Personalised cancer treatment.

The lecture requires an active participation of the students. All students will participate in individual or group work focussing on specific subject of the lecture. Students will have ample time for preparation during lecture time.

Additional informations are given during the lecture.

Prerequisites / notice


About 5 talks on applied statistics.

ZüKoSt: Seminar on Applied Statistics

Scientific talks and discussions on changing subjects.

Handouts with reproductions of all presented transparencies will be distributed.

None

Discussion of current topics in DNA-repair, recombination, replication, and cancer.

Discussion of current topics in DNA-repair, recombination, replication, and cancer.

The Statistical Consulting service is open for all members of ETH, including students, and partly also to other persons.

Advice for analyzing data by statistical methods.

The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation). You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).

Interaction seminar. Student-mediated presentations, guests and discussions on current themes in ecology, evolutionary and population biology.

Getting familiar with scientific arguments and discussions. Overview of current research topics. Making contacts with fellow students in other groups.

Scientific talks and discussions on changing subjects.

For information and details: http://www.eco.ethz.ch/news/zis

Contact: Lehre-eve@env.ethz.ch . Tel. 044 632 2223. See also http://stat.ethz.ch/consulting

Requirements: Knowledge of the basic concepts of statistics is desirable.

The course is a literature seminar or "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.

You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance.

You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation). You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).

The course language is English or German and may depend on the speaker.

This is not a course, but a consulting service. There are no exams nor credits.

We highly recommend to contact the consulting service when planning a project, not only towards the end of analyzing the resulting data!

Contact: beratung@stat.math.ethz.ch . Tel. 044 632 2223. See also http://stat.ethz.ch/consulting

Requirements: Knowledge of the basic concepts of statistics is desirable.

The course language is English or German and may depend on the speaker.
Abstract: This monthly meeting is a platform for Zurich-based immunology research groups to present and discuss their ongoing research projects. At each meeting three PhD students or Postdocs from the participating research groups present an ongoing research project in a 30 min seminar followed by a plenary discussion.

Objective: The aim of this monthly meeting is to provide further education for master and doctoral students as well as Postdocs in diverse topics of immunology and to give an insight in the related research. Furthermore, this platform fosters the establishment of science- and technology-based interactions between the participating research groups.

Content: Presentation and discussion of current research projects carried out by various immunology-oriented research groups in Zurich.

Lecture notes: None

551-1405-00L Electron Cryomicroscopy Seminar
For students and scientists interested in electron cryomicroscopy.

Objective: The goal of the seminar is to provide an exchange forum for anyone interested in electron cryomicroscopy (tomography and single particle).

Prerequisites / Notice: The first ~10 minutes are used for exchange on instrument status and technical issues, followed by a ~30 min presentation and discussion of a specific project. The seminar can also be used to discuss current literature and report from conferences. Presented project data are confidential. Sign-up for seminar announcements by emailing pilhofer@biol.ethz.ch.

551-1106-00L Progress Reports in Microbiology and Immunology

Objective: The goal of the seminar is to provide an exchange forum for anyone interested in electron cryomicroscopy (tomography and single particle).

Prerequisites / Notice: The first ~10 minutes are used for exchange on instrument status and technical issues, followed by a ~30 min presentation and discussion of a specific project. The seminar can also be used to discuss current literature and report from conferences. Presented project data are confidential. Sign-up for seminar announcements by emailing pilhofer@biol.ethz.ch.

551-0209-00L Sustainable Plant Systems (Seminar)
Participants will be able to discuss and understand sustainability in the context of plant science research.

Objective: Key objectives for the seminar are that (1) participants will be able to discuss issues of sustainability in the context of plant science research topics, e.g. how a specific research topic is important for understanding and advancing sustainability of plant systems and that (2) participants will be able to phrase their own visions for sustainability in plant sciences, their group work topic and their own MSc or PhD project. Plant science research topics will be on conservation agriculture, agro-ecology, plant breeding for orphan crops and methane emissions from wetland ecosystems.

551-1121-00L Progress Reports in Microbial Glycobiology and Fungal Defense Mechanisms

Objective: Precise and transparent presentation of research findings in relation to the current literature, critical discussion of experimental data and their interpretation, development and presentation of future research aims.

Biology (General Courses) - Key for Type

| W+ | Eligible for credits and recommended |
| W | Eligible for credits |
| Dr | Suitable for doctorate |
| E- | Recommended, not eligible for credits |
| O | Compulsory |
| Z | Courses outside the curriculum |

Key for Hours

| V | lecture |
| P | practical/laboratory course |
| G | lecture with exercise |
| A | independent project |
| U | exercise |
| D | diploma thesis |
| S | seminar |
| R | revision course / private study |
| K | colloquium |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Compulsory Subjects First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0291-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6 credits</td>
<td>4V+2U</td>
<td>E. W. Farkas</td>
</tr>
</tbody>
</table>

**Abstract**

Mathematics I/II is an introduction to one- and multidimensional calculus and linear algebra emphasizing on applications.

**Objective**

Students understand mathematics as a language for modeling and as a tool for solving practical problems in natural sciences. Students can analyze models, describe solutions qualitatively or calculate them explicitly if need be. They can solve examples as well as their practical applications manually and using computer algebra systems.

**Content**

Einführung in die Differential- und Integralrechnung von Funktionen einer Variablen und Anwendungen:


**Literature**

Siehe Lernmaterialien > Literatur

L. Papula, Mathematik für Ingenieure und Naturwissenschaftler, 11. Auflage, Vieweg und Teubner

Th. Wihler, Mathematik für Naturwissenschaften, 2 Bände; Einführung in die Analysis, Einführung in die Lineare Algebra; Haupt-Verlag Bern, UTB

Ch. Blatter, Lineare Algebra; VDF

H. H. Storrer: Einführung in die mathematische Behandlung der Naturwissenschaften I; Birkhäuser.

**Prerequisites / notice**


Der Zugang zu den Übungsserien erfolgt online.

Vorlesungsverzeichnis > Lernmaterialien > Material zur Vorlesung

<table>
<thead>
<tr>
<th>252-0852-00L</th>
<th>Foundations of Computer Science</th>
<th>O</th>
<th>4 credits</th>
<th>2V+2U</th>
<th>L. E. Fässler, H.J. Böckenhauer, M. Dahinden, D. Komm, H. Lehner</th>
</tr>
</thead>
</table>

**Abstract**

Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects.

The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.

**Objective**

The students learn to

- understand the role of computer science in science,
- to control computer and automate processes of problem solving by programming,
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

**Content**

1. The role of computer science in science
2. Introduction to Programming with Python
3. Modeling and simulations
4. Introduction to Matrices with Matlab
5. Visualizing multidimensional data
6. Data management with lists and tables
7. Data management with a relational database
8. Universal methods for algorithm design

**Lecture notes**

All materials for the lecture are available at www.gdi.ethz.ch

**Prerequisites / notice**

This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

<table>
<thead>
<tr>
<th>551-0105-00L</th>
<th>Fundamentals of Biology IA</th>
<th>O</th>
<th>5 credits</th>
<th>5G</th>
<th>M. Aebi, E. Hafen</th>
</tr>
</thead>
</table>

**Abstract**

The course provides an introduction to the basics of molecular- and cell biology and genetics.

**Objective**

Introduction to modern biology and to principal biological concepts.

**Content**

The course is divided into several chapters:

1. Basic principles of Evolution.
2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules
3. The cell: structure; membrane structure and function, cell cycle
4. Metabolism: Respiration; Photosynthesis; Fermentation
5. Inheritance: meiosis and sexual reproduction; Mendelian genetics, chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution

**Lecture notes**

None.

**Literature**

The text-book "Biology" (Campbell, Reece) (10th edition) is the basis of the course. The structure of the course is largely identical with that of the text-book.

**Prerequisites / notice**

Certain sections of the text-book must be studied by self-instruction.

<table>
<thead>
<tr>
<th>529-1001-01L</th>
<th>General Chemistry (for Biology/Pharmacy/HST)</th>
<th>O</th>
<th>4 credits</th>
<th>4V</th>
<th>W. Uhlig</th>
</tr>
</thead>
</table>

**Abstract**

The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

**Objective**

The course is designed to provide an understanding of the basic principles and concepts of general and inorganic chemistry.
The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

Literature
- Brown, LeMay, Bursten CHEMIE (deutsch)
- Housecroft and Constable, CHEMISTRY (englisch)
- Octoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

529-1011-00L Organic Chemistry I (for students of Biology, Pharmaceutical Sci., and Health Sci. & Tech.) O 4 credits 4G C. Thilgen

Abstract
Fundamentals of Organic Chemistry: molecular structure. Bonding and functional groups; nomenclature; resonance and aromaticity; stereochemistry; conformation; bond strength; organic acids and bases; basic reaction thermodynamics and kinetics; reactive intermediates: carbanions, carbenium ions and radicals.

Objective
Understanding the basic concepts and definitions of organic chemistry. Knowledge of the functional groups and classes of compounds that are important in biological systems. Foundations for the understanding of the relationship between structure and reactivity.

Content

Lecture notes
Printed lecture notes are available. Exercises, answer keys and other handouts can be downloaded from the Moodle course “Organic Chemistry I” of the current semester (https://moodle-app2.let.ethz.ch).

Literature
Lecture notes are available. As a supplement, a selection of textbooks is proposed during the course.

Prerequisites / notice
The course consists of plenary lectures (2 h per week) and problem-solving lessons (2 h per week, groups of ca. 25 people). In addition, online exercises are available in the e-learning environment Moodle (Course OC I).

First Year Laboratory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-1001-00L</td>
<td>Laboratory Course General Chemistry (for Biology and Pharmacy)</td>
<td>O</td>
<td>6 credits</td>
<td>8P</td>
<td>R. O. Kiasner, K.H. Allmann, J. Hall, D. Neri, G. Schneider, M. D. Wörle</td>
</tr>
</tbody>
</table>

Abstract
Introduction to the practical work in a chemistry laboratory. The most important manipulations and techniques are treated, as well as the most fundamental chemical reaction types.

Objective
- Knowledge of the basic chemical laboratory methods.
- Basic knowledge of the scientific approach in experimenting.
- Observation and interpretation of real-world chemical processes.
- Keeping of a reliable laboratory journal.

Content
- Simple chemical methods and calculations.
- Separation techniques.
- Physical measurements: mass, volume, pH, optical spectra.
- Ionic solids (salts).
- Acid/base chemistry, buffers.
- Redox reactions.
- Metal complexes.
- Titration methods and quantitative spectrometry.
- Introduction to qualitative analysis.

Lecture notes
Course manual in German (is handed out to the students at the begin of the lessons). Language: German, English upon request. PDF files available at http://acac1.ethz.ch/praktikum/docs.html

Literature

is a suitable textbook.

Prerequisites / notice
This practical course causes costs for materials and chemicals. The costs are charged to the students at the end of semester.

2. Year, 3. Semester

Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1023-00L</td>
<td>Physical Chemistry I (for Biology and Pharmacy)</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>R. Riek, H. P. Lüthi</td>
</tr>
</tbody>
</table>

Abstract

Objective
Understanding the fundamental thermodynamical properties of chemical and biological systems.

Content

Lecture notes
in process, will be distributed at the beginning of the first lecture

Literature

Prerequisites / notice
Prerequisite: mathematics I-II, functions of multiple variables, partial derivatives.

551-0103-00L Fundamentals of Biology II: Cell Biology | O | 5 credits | 5V | E. Hafen, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner |

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 215 of 1571
The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, medical biology, and others.

**Objective**

The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.

**Content**

The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

**Lecture notes**

The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the nethz (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.

**Prerequisites / notice**

Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.

---

**551-1003-00L**

Methods of Biological Analysis

**Abstract**

Principles of the most important separation techniques and the interpretation of molecular spectra.

**Objective**

The course will teach the basis and typical applications of methods for the analysis of nucleic acid sequences, mass spectrometric analysis of proteins and proteomes and advanced light and fluorescent imaging methods.

**Content**

Knowledge of the necessary basics and the possibilities of application of the relevant spectroscopical and separation methods in analytical chemistry.

**Prerequisites**

Knowledge of the theoretical basis of the methods for nucleic acid sequence analysis, mass spectrometry based protein and proteome analysis and advanced light and fluorescent imaging methods, and an understanding of the application of these principles in experimental biology.

**Literature**


**Prerequisites / notice**

Materials supporting the lectures and exercises will be made available via Moodle.

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**401-0643-13L**

Statistics II

**Abstract**

Vertiefung von Statistikmethoden. Nach dem detaillierten Fundament aus Statistik I liegt nun der Fokus auf konzeptuelle Breite und konkreter Problemlösungsfähigkeit mit der Statistiksoftware R.

**Objective**


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### Elective Blocks

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 216 of 1571
### Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography)

**Abstract**
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.

**Objective**
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution.

**Content**
Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.

**Literature**
Textbook:
Evolutionary Analysis
Scott Freeman and Jon Herron

**Prerequisites / notice**
The exam is based on lecture and textbook.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-0435-00L</td>
<td>Systematic Biology: Zoology</td>
<td>O</td>
<td>3</td>
<td>2V+2P</td>
<td>O. Y. Martin, M. Greeff</td>
</tr>
<tr>
<td>Abstract</td>
<td>Lecture: The lecture provides an overview of animal diversity. Using key selected groups, phylogenetic, morphological and ecological aspects are addressed. Two priority topics are the arthropods and the vertebrates (including vertebrate fauna of Switzerland). Practical: Knowledge of selected animal groups and their characteristics (supplementing the lecture) and of the basic methods. Lecture: The systematic classification of animals and the characteristics of the most important animal groups, basic animal body plans. Practical: Examples of selected animal groups and their characteristics; acquire the relevant skills: simple preparations, dissection, microscopy, drawing, protocols. Content Lecture: Body plans, characteristics, diversity and phylogenetic position of the main groups of Protozoa, Invertebrates, and Vertebrates, with a special focus on Arthropods and Vertebrates (including vertebrate fauna of Switzerland). Practical: Macroscopic and microscopic study of selected Protozoa, Invertebrates (especially insects) and Vertebrates: morphology and anatomy; behaviour, mainly locomotion, feeding, and reproduction. Lecture notes A script for the course will be sold in the lecture, and additional material will be handed out (particularly in the practical). Literature No further literature required, the script contains suggestions for further reading.</td>
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<tr>
<td>551-0227-00L</td>
<td>Mycology</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>M. Aebi</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture gives an introduction into the field of Mycology. It provides an overview of the fungal lifestyle (hyphal growth/mycelium; reproductive cycles; ecology of the fungi; use of fungi) Understanding the fungal life form. Knowledge of the specific properties of the fungal cell Knowledge of the different reproductive cycles in all fungal phyla Knowledge of the different nutritional modes of the fungi; correlation with habitat and ecology Knowledge of the application of fungi in food production and biotechnology The lecture focuses on the following topics within Mycology: 1. The fungal lifestyle 2. Differentiation processes of the Mycelium 3. Reproductive cycles and systematic grouping of fungi 4. Ecology of the fungi 5. Use of fungi</td>
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</tr>
<tr>
<td>Literature</td>
<td>none; hand-outs will be prepared before the lectures</td>
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<tr>
<td>Prerequisites / notice</td>
<td>none</td>
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### Biodiversity

**Number**  | **Title**                                      | **Type** | **ECTS** | **Hours** | **Lecturers** |
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<tbody>
<tr>
<td>701-0245-00L</td>
<td>Introduction to Evolutionary Biology</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>G. Velicer, S. Wielgoss</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.</td>
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<tr>
<td>Objective</td>
<td>This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.</td>
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<tr>
<td>Content</td>
<td>These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The exam is based on lecture and textbook.</td>
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</table>

**Number**  | **Title**                                      | **Type** | **ECTS** | **Hours** | **Lecturers** |
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<tbody>
<tr>
<td>529-0229-00L</td>
<td>Practical Course Organic Chemistry (for Students of Biology and Pharmaceutical Sciences)</td>
<td>O</td>
<td>8</td>
<td>12P</td>
<td>C. Thilgen, F. Diederich, Y. Yamakoshi</td>
</tr>
<tr>
<td>Abstract</td>
<td>Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography) Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).</td>
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### Cellular and Molecular Biology

**Number**  | **Title**                                      | **Type** | **ECTS** | **Hours** | **Lecturers** |
<table>
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<tbody>
<tr>
<td>701-0245-00L</td>
<td>Introduction to Evolutionary Biology</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>G. Velicer, S. Wielgoss</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.</td>
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<tr>
<td>Objective</td>
<td>This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.</td>
<td></td>
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<tr>
<td>Content</td>
<td>These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The exam is based on lecture and textbook.</td>
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</tbody>
</table>

**Number**  | **Title**                                      | **Type** | **ECTS** | **Hours** | **Lecturers** |
<table>
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</thead>
<tbody>
<tr>
<td>529-0229-00L</td>
<td>Practical Course Organic Chemistry (for Students of Biology and Pharmaceutical Sciences)</td>
<td>O</td>
<td>8</td>
<td>12P</td>
<td>C. Thilgen, F. Diederich, Y. Yamakoshi</td>
</tr>
<tr>
<td>Abstract</td>
<td>Latest online enrolment is 10 days before the beginning of the semester. Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography) Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).</td>
<td></td>
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</tbody>
</table>

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 217 of 1571
Objective Learn the basic techniques for the preparation and purification of organic compounds. Learn to take accurate notes of the experiments. Deepen the understanding of reaction mechanisms.

Content Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography). Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses). Introduction to database searches (Reaxys, SciFinder).

Lecture notes Documentation will be handed out at the beginning of the course.


Prerequisites / notice The basic reactions of Organic Chemistry and their mechanisms should be known (cf. course 529-1012-00L Organic Chemistry II for Students of Biology, Pharmaceutical Sciences, and Health Sci. and Tech.).

As a prerequisite, all participants need to pass the "Safety Test HCI Chemie_V2 English" (see https://moodle-app2.let.ethz.ch). A printout of the certificate generated by the system needs to be presented to the teaching assistants prior to starting lab work.

### Biological Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0229-00L</td>
<td>Practical Course Organic Chemistry (for Students of Biology and Pharmaceutical Sciences)</td>
<td>O</td>
<td>8 credits</td>
<td>12P</td>
<td>C. Thilgen, F. Diederich, Y. Yamakoshi</td>
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</table>

Abstract Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography). Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).

Objective Learn the basic techniques for the preparation and purification of organic compounds. Learn to take accurate notes of the experiments. Deepen the understanding of reaction mechanisms.

Content Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography). Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses). Introduction to database searches (Reaxys, SciFinder).

Lecture notes Documentation will be handed out at the beginning of the course.


Prerequisites / notice The basic reactions of Organic Chemistry and their mechanisms should be known (cf. course 529-1012-00L Organic Chemistry II for Students of Biology, Pharmaceutical Sciences, and Health Sci. and Tech.).

As a prerequisite, all participants need to pass the "Safety Test HCI Chemie_V2 English" (see https://moodle-app2.let.ethz.ch). A printout of the certificate generated by the system needs to be presented to the teaching assistants prior to starting lab work.

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1121-00L</td>
<td>Inorganic Chemistry (for Biology)</td>
<td>O</td>
<td>3 credits</td>
<td>2+4+U</td>
<td>A. Mezzetti, A. Fedorov</td>
</tr>
</tbody>
</table>

Abstract Introduction to orbital concept and to the binding theory in complexes of the transition metals.


Lecture notes Can be bought at the HCI-shop.


### 3. Year, 5. Semester

#### Concept Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-2413-00L</td>
<td>Evolutionary Genetics</td>
<td>W</td>
<td>6 credits</td>
<td>4V</td>
<td>T. Städel, A. Widmer, P. C. Brunner, M. C. Fischer</td>
</tr>
</tbody>
</table>

Abstract The concept course 'Evolutionary Genetics' consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

Objective The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods and explanatory power of evolutionary genetics.

Content Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding, natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory. Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossingbreeding, effects on fitness; Fisher's fundamental theorem. Ecological Genetics - Concepts and methods for the study of genetic variation and its role in adaptation, reproductive isolation, hybridization and speciation.

Lecture notes Handouts


Prerequisites / notice There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-0307-00L</td>
<td>Molecular and Structural Biology I: Protein Structure and Function</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>R. Glockshuber, K. Locher, E. Weber-Barr</td>
</tr>
</tbody>
</table>

D-BIOL BSc students are obliged to take part I and part II (next semester) as a two-semester course.

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 218 of 1571
Abstract
Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

Objective
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

Lecture notes
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

Basics:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.
- Berg, Tymoczko, Stryer: Biochemistry (5th edition), Freeman (2001); Current topics: References will be given during the lectures.
**Lecture notes**

- Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

**Literature**

- Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

**Prerequisites / notice**

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

### 529-0731-00L Nucleic Acids and Carbohydrates

**Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines**

**Abstract**

Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Objective**

Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Content**

Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccine

**Lecture notes**

- no script

**Literature**

- Mainly based on recent original literature, a detailed list will be distributed during the first lecture

### 551-0317-00L Immunology I

**Introduction into structural and functional aspects of the immune system.**

**W** 3 credits 2V A. Oxenius, M. Kopf

**Abstract**

Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

**Objective**

Introduction into structural and functional aspects of the immune system.

**Content**

- Basic knowledge of the mechanisms and the regulation of an immune response.
  - Introduction and historical background
  - Innate and adaptive immunity. Cells and organs of the immune system
  - B cells and antibodies
  - Generation of diversity
  - Antigen presentation and Major Histocompatibility (MHC) antigens
  - Thymus and T cell selection
  - Autoimmunity
  - Cytotoxic T cells and NK cells
  - Th1 and Th2 cells, regulatory T cells
  - Allergies
  - Hypersensitivities
  - Vaccines, immune-therapeutic interventions

**Lecture notes**

- Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

**Literature**


**Prerequisites / notice**

- Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

### 551-1295-00L Introduction to Bioinformatics: Concepts and Applications

**W** 6 credits 4G W. Gruissem, K. Bärenfaller, A. Callisch, G. Capitani, J. Fütterer, M. Robinson, A. Wagner

**Abstract**

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

**Objective**

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms* that will be offered in the following semester.

**Content**

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

### 376-1305-10L Neurobiology

**W** 6 credits 4V M. E. Schwab, E. Stoeckli, L. Filli, K. A. Martin, further lecturers

**Abstract**

Development of the nervous system (NS): the adult NS, plasticity and regeneration, sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, diseases of the NS.
Objective
Overview of normal development, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content
Development: Early development of the nervous system, cellular level, nerve fiber growth, building of neuronal networks; biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes
Structure, Plasticity and Repair of the Nervous System (376-1305-01L): Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures.

Block Courses

Block Courses in 1st Quarter of the Semester
From 20.09.2016 13:00 hr to 12.10.2016 17:00 hr

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0333-00L</td>
<td>Biodiversity and Ecological Significance of Fungi</td>
<td>W</td>
<td>6</td>
<td>7P</td>
<td>A. Leuchtmann, R. Berndt,</td>
</tr>
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<td></td>
<td>B. Senff-Inft</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to the biology, systematics and ecology of the important fungal groups. The participants will study primarily fungal materials that they collect during field excursions or that they isolate in the laboratory.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of characteristics, life style and ecological significance of major fungal and fungal-like groups. Become acquainted with methods for collecting, microscopic examination and identification of fungi.</td>
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<tr>
<td>Lecture notes</td>
<td>Übersichten und Skriptunterlagen zum Kursstoff werden abgegeben.</td>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>551-0191-00L</td>
<td>Practical Aspects of Plant Biotechnology</td>
<td>W</td>
<td>6</td>
<td>7G</td>
<td>K. Bärenfeller, J. Füterer</td>
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<tr>
<td>Number of participants limited to 6.</td>
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<tr>
<td>Abstract</td>
<td>The course covers multidisciplinary aspects of plant molecular biology and green biotechnology. The participants will acquire theoretical and practical introduction on diverse topics, including, generation and molecular characterization of transgenic plants; allelic mining from genetic resources and on strategies to improve plants against biotic &amp; abiotic stresses and for their nutritional value</td>
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<tr>
<td>Objective</td>
<td>In this block course, students will gain conceptual and practical introduction to crop biotechnology research. In addition to the theoretical overview of current trends in plant biotechnology, students will envision the practical application of the knowledge gained through hands-on training on the plant molecular biology laboratory techniques. The course will introduce the potential of plant molecular biology and genetic transformation as a tool for gene identification, gene function, crop improvement and commercial application. The course will also allow the students to understand and critically evaluate the literature in this research field.</td>
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<tr>
<td>Content</td>
<td>Lectures will particularly focus on the contribution of biotechnology towards crop improvement, with examples from our own work on crops including rice and wheat. Following topics will be covered: Green biotechnology: status and prospects -Plant genetic transformation (methods) -Molecular characterization of transformed plants -Introduction to selection marker systems (examples, antibiotic and herbicide resistance, phosphomannose-isomerase, marker-free systems, visible markers) -Introduction to promoter types (example tissue specific promoters) -Plant culture techniques -Crop improvement through biotechnology (examples from our work on rice, wheat and cassava) -Gene mining from genetic resource collections A visit to the ETH greenhouse facilities at Eschikon will provide an opportunity to visualize and discuss different rice, wheat and cassava projects performed at the ETH Plant Biotechnology Lab.</td>
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<tr>
<td>Lecture notes</td>
<td>For the practical part, protocols will be distributed within the course and Lecture material will be made available.</td>
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<tr>
<td>Literature</td>
<td>Relevant literature information will be provided within the course.</td>
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<tbody>
<tr>
<td>551-0193-00L</td>
<td>Biological Information Mining</td>
<td>W</td>
<td>6</td>
<td>7G</td>
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<tr>
<td>Number of participants limited to 8.</td>
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<tr>
<td>Abstract</td>
<td>Students will use lists of genes obtained in real experiments and learn how to obtain gene-centered information from literature and databases. They will use tools for gene function prediction and visualization of protein-protein interaction networks. The work will lead to a more meaningful annotation of co-detected genes and generate a hypothesis about their functional relationship.</td>
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</tbody>
</table>
Content

Many new biological analysis methods result in lists of genes or proteins related to biological structures, functions, or processes. The information available about the genes or proteins is often scattered in multiple databases and publications, making it difficult to extract and uncover common features or relationships among the biological molecules. In the course students will use lists of genes or proteins from ongoing experiments in the laboratory and learn how to find and assemble gene-centered information in the literature, different databases and with analysis tools. The training and research will lead to a better and more meaningful annotation of co-detected genes members and generate a hypothesis about their functional relationship. The work will be done exclusively using a computer. Students will work independently but with close supervision by experienced scientists. Daily discussions of the work will ensure progress. The computer work will be accompanied by lectures on theoretical and practical aspects of databases, gene networks and the project context of the gene lists that will be analyzed. Students will present their results and hypotheses at the end of the block course.

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0347-00L</td>
<td>Molecular Mechanisms of Cell Growth and Polarity</td>
<td>W</td>
<td>6 credits</td>
<td>7G</td>
<td>R. Kroschewski, Y. Barral, S. Jessberger, M. Peter</td>
</tr>
</tbody>
</table>

Abstract

Introduction to the principles and molecular mechanisms of cell polarity, using animal cells and fungi as model systems.

Objective

The students learn to describe the principles and molecular mechanisms of cell polarity, using different model systems as examples:
- Animal cells during epithelial and neuronal differentiation
- Fungi during morphogenesis and aging.

Based on lectures, literature reading, discussions, presentations and practical lab work the students will be able to compare experimental strategies in different model systems, and to develop open questions in the field of cell polarity. Students will also know about the mechanisms and consequences of asymmetric cell division such as those performed by stem cells and asymmetric protein functions during morphogenesis and aging.

Content

During this Block-Course, the students will learn to:
1. describe and compare the principles and molecular mechanisms of cell polarity in fungi and animal cells,
2. apply, evaluate and compare experimental strategies in the different model systems, and
3. select the best model system to answer a particular question.

Students - in groups of 2 or max 3 - will be integrated into a research project connected to the subject of the course, within one of the participating research groups.

Lecture notes

There will be optional papers to be read before the course start. They serve as framework orientation for the practical parts of this block course and will be made accessible to you shortly before the course starts on the relevant Moodle site.

Literature

Documentation and recommended literature (review articles) will be provided during the course.

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-1129-00L</td>
<td>Understanding and Engineering Microbial Metabolism</td>
<td>W</td>
<td>6 credits</td>
<td>7P</td>
<td>J. Vorholt-Zambelli</td>
</tr>
</tbody>
</table>

Abstract

This laboratory course has a focus on current research topics in our laboratory related to metabolic engineering, the general understanding of metabolism, and is focused particularly on C1-metabolism. Projects will be conducted in small groups.

Objective

The course aims at introducing key principles of metabolic engineering and techniques applied in metabolism related research. The main focus of this block course is on practical work and will familiarize participants with complementary approaches, in particular genetic, biochemical and analytical techniques. Results will be presented by students in scientific presentations.

Content

The course and will include topics such as pathway elucidation & engineering and related ongoing research projects in the lab. Experimental work applied during the course will comprise methods such as cloning work & transformation, growth determination, enzyme activity assays, liquid-chromatography mass-spectrometry and dynamic labeling experiments.

Lecture notes

None

Literature

Will be provided at the beginning of the course.

<table>
<thead>
<tr>
<th>Course Code</th>
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</thead>
<tbody>
<tr>
<td>551-0916-00L</td>
<td>Learning and Teaching Biology</td>
<td>W</td>
<td>6 credits</td>
<td>7G</td>
<td>E. Hafen</td>
</tr>
</tbody>
</table>

Abstract

This course represents an introduction to recent research into student learning on the conceptual foundations of modern biology, together with pedagogical methods associated with effective instruction and its valuation. Students will be involved in active research into conceptual and practical issues involved in biology education and methods to discover student preconceptions.

Objective

Provides an overview on student's learning and shows ways to make the classroom experience more engaging and effective for students. Students will learn to produce a research-based paper on a project they work on during the course.

Content

The course is not taught by a particular book, but recommended literature (review articles and selected primary literature) will be provided during the course.

Literature

See the introductory video to the course here: http://youtu.be/GFJuNncSsdE

Block Courses in 2nd Quarter of the Semester

From 13.10.2016 08:00 hr to 4.11.2016 17:00 hr

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0345-00L</td>
<td>Mechanisms of Bacterial Pathogenesis</td>
<td>W</td>
<td>6 credits</td>
<td>7P</td>
<td>W.D. Hardt</td>
</tr>
</tbody>
</table>

Abstract

Research laboratory class in small groups. Research projects on current topics in cellular microbiology and bacterial pathogenesis are assigned to each student.

Objective

Introduction to a current topic in cellular microbiology and/or molecular genetics of a bacterial pathogen. Experimental work in the research lab and introduction to the current lab techniques. Work with the current research literature in bacterial pathogenesis. Writing of a research protocol. Requirement for obtaining the credit points: oral presentation of the research project and evaluation of the research protocol.

Content

Research projects on the model pathogen Salmonella.

Lecture notes

none

Literature

Literature will be selected with reference to the assigned research project.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0421-00L</td>
<td>Biology and Ecology of Fungi in Forests</td>
<td>W</td>
<td>6 credits</td>
<td>7G</td>
<td>I. L. Brunner, S. H. Egli, D. H. Rigling</td>
</tr>
</tbody>
</table>

Abstract

Introduction of the biological and ecological basics of fungi in forests. Focusing on mycorrhizal, saprobic, and pathogenic fungi and their functional relevance in the forest ecosystems. To get to know current methodological research approaches on the basis of selected examples with practical works in forest and lab as well as excursions and lectures.

Objective

Knowledge of the fungi of forest and its ecological significance. Knowing of current methodological research approaches. Self-reliant and deepened activities of selected topics of fungi from forests.
Content | Introduction of the biological and ecological basics of fungi in forests. Focusing on mycorrhizal, saprobic, and pathogenic fungi and their functional relevance in the forest ecosystems. To get to know current methodological research approaches on the basis of selected examples with practical works in forest and lab as well as excursions and lectures.

Lecture notes | Unterlagen zum Kurs werden abgegeben.


Prerequisites / notice | Der Blockkurs findet an der Eidg. Forschungsanstalt WSL in Birmensdorf statt. Der Wald vor der Haustüre des Institutes macht diesen Kurs besonders praxisnah.

Erreichbarkeit mit Tram 14 bis Triemli, danach PTT-Bus 220 oder 350 bis Birmensdorf Sternen/WSL, oder mit S9 bis Birmensdorf SBB und mit PTT-Bus eine Station in Richtung Zürich bis Birmensdorf Sternen/WSL.

551-0359-00L | Plant Biochemistry
Number of participants limited to 10.

Abstract | In this block course, students actively participate in ongoing research projects on plant metabolism and are tutored individually by doctoral students and postdocs. In a lecture series, the theoretical background for the projects and their interrelationship is provided, and in a seminar series, students will present their projects as well as discuss topical recent publications.

Objective | In this block course, students actively participate in ongoing research projects on plant metabolism and are tutored individually by doctoral students and postdocs.

Content | Participation in the following research projects will be possible: Photosynthetic metabolism: how is photo-assimilated carbon allocated to sustain plant growth? Chloroplast biology: how is chloroplast function integrated with that to the whole cell? Starch biosynthesis and degradation: how are complex, semi-crystalline starch granules made from simple sugars, and once made, how are they degraded again to release the stored carbohydrate? Regulation of metabolism through protein-protein interaction; how and why do proteins involved in starch metabolism interact with each other to form multi-subunit enzymes and multi-enzyme complexes? Sugar sensing: How does a plant know how much sugar it has, and how does this influence development.

Lecture notes | No script

Literature | Lists of individual reading assignments will be handed out.

551-1513-00L | Cancer Cell Signaling: Mechanisms, Targets and Therapeutic Approaches
Number of participants limited to 10.

Abstract | This course will consider the pathogenetic landscape of cancer, explore how abnormalities of cellular information management cause cancer and demonstrate how the integrated application of modern omics technologies, mouse cancer models and human pathology provides a foundation for developing individualized cancer therapeutics. The course combines practical work with discussions and presentations.

Objective | Insights into and overview about the genetic alterations that underlie different cancer types, the complex cancer cell circuitries governing tumor development, modern approaches used in contemporary basic and translational cancer research and sophisticated strategies to control individual cancers and combat drug resistance.

Lecture notes | None

Literature | Will be provided for each of the projects at the beginning of the course.

551-1147-00L | Bioactive Natural Products from Bacteria
Number of participants limited to 8.

Abstract | Lab course. In small groups projects of relevance to current research questions in the field of bacterial natural product biosynthesis are addressed.

Objective | Introduction to relevant subjects of the secondary metabolism of bacteria. Training in practical work in a research laboratory. Scientific writing in form of a research report.

Content | Research project on bacteria that produce bioactive natural products (e.g., Streptomycetes, Cyanobacteria, uncultivated bacteria). The techniques used will depend on the project, e.g. PCR, cloning, natural product analysis, precursor feeding studies, enzyme expression and analysis.

Lecture notes | None

Literature | Will be provided for each of the projects at the beginning of the course.

551-0351-00L | Membrane Biology
Number of participants limited to 21.

Abstract | The course will introduce the students to the key concepts in membrane biology and will allow them to be involved in laboratory projects related to that broad field. The course will consist of lectures, literature discussions, and practical laboratory work in small groups. Results of the practical projects will be presented during the poster session at the end of the course.

Objective | The aim of the course is to expose the students to a wide range of modern research areas encompassed by the field of membrane biology.

Content | Students will be engaged in research projects aimed at understanding the biological membranes at the molecular, organellar and cellular levels. Students will design and perform experiments, evaluate experimental results, analyze the current scientific literature and understand the relevance of their work in the context of the current state of the membrane biology field.

Lecture notes | None

Literature | The recommended literature, including reviews and primary research articles, will be provided during the course.

551-0355-00L | Phytophathology
Number of participants limited to 12.

Abstract | Fundamentals (theoretical and practical) in phytopathology, e.g. interaction between plants and plant-pathogenic microorganisms, morphology and lifestyles of plant-pathogenic fungi, evolution of plant-pathogenic fungi, biological control of plant diseases

Objective | Fundamentals (theoretical and practical) in phytopathology, e.g. interaction between plants and plant-pathogenic microorganisms, morphology and lifestyles of plant-pathogenic fungi, evolution of plant-pathogenic fungi, biological control of plant diseases

Insight into ongoing research projects

BEGIN Block Courses in 3rd Quarter of the Semester
From 8.11.2016 13:00 hr to 30.11.2016 17:00 hr

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
551-0355-00L | Phytophathology | W | 6 credits | 7G | M. Maurhofer Bringolf, B. McDonald

Abstract | Fundamentals (theoretical and practical) in phytopathology, e.g. interaction between plants and plant-pathogenic microorganisms, morphology and lifestyles of plant-pathogenic fungi, evolution of plant-pathogenic fungi, biological control of plant diseases

Objective | Fundamentals (theoretical and practical) in phytopathology, e.g. interaction between plants and plant-pathogenic microorganisms, morphology and lifestyles of plant-pathogenic fungi, evolution of plant-pathogenic fungi, biological control of plant diseases

Insight into ongoing research projects
Experiments within ongoing phytopathological research projects
Macro- and microscopic diagnostic of plant diseases

Theoretical courses:

Fundamentals of phytopathology, e.g. interaction between plants and plant-pathogenic microorganisms, morphology and lifecycles of plant-pathogenic fungi, evolution of plant-pathogenic fungi, biological control of plant diseases

Lecture notes

Biological Chemistry B: New Enzymes from Directed Evolution Experiments

Abstract

During the block course in the fall semester, we will carry out biological-chemical enzyme evolution experiments using molecular genetic mutation technologies and in vivo selection in recombinant bacterial strains. By working in parallel, teams of 2 participants each will generate a variety of different variants of a chorismate mutase. Individual enzyme catalysts will be purified and subsequently characterized using several different spectroscopic methods. The detailed chemical-physical analyses include determination of the enzymes’ kinetic parameters, their molecular mass, and the integrity of the protein structure. The results obtained from the individual evolution experiments will be compared and discussed at the end of the class in a final seminar. We expect that during this lab course we will not only generate novel enzymes, but also gain new mechanistic insights into the investigated catalyst.

Objective

All technologies used for the experiments will be explained to the students in theory and in practice with the goal that they will be able to independently apply them for the course project and in future research endeavors. After the course, an individual report about the results obtained has to be prepared.

Content

The class deals with a specifically designed and genuine research project. We intend to carry out biological-chemical enzyme evolution experiments using molecular genetic mutation technologies and in vivo selection in recombinant bacterial strains. By working in parallel, teams of 2 participants each will generate a variety of different variants of a chorismate mutase. Individual enzyme catalysts will be purified and subsequently characterized using several different spectroscopic methods. The detailed chemical-physical analyses include determination of the enzymes’ kinetic parameters, their molecular mass, and the integrity of the protein structure. The results obtained from the individual evolution experiments will be compared and discussed at the end of the class in a final seminar. We expect that during this lab course we will not only generate novel enzymes, but also gain new mechanistic insights into the investigated catalyst.

Lecture notes

A script will be distributed to the participants on the first day of the course.

Literature

General literature to "Directed Evolution" and chorismate mutases, e.g.:


Methods in Cellular Biochemistry

Abstract

Students will learn about biochemical approaches to analyze cellular functions. The course consists of practical projects in small groups, lectures and literature discussions. The course concludes with the presentation of results at a poster session.

Objective

Students will learn to design, carry out and assess experiments using current biochemical and cell biological strategies to analyze cellular functions in a wide range of model systems. In particular they will learn novel imaging techniques along with biochemical approaches to understand fundamental cellular pathways. Furthermore, they will learn to assess strengths and limitations of the different approaches and be able to discuss their validity for the analysis of cellular functions.

Literature

Documentation and recommended literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice

This course will be taught in English.

Insulin Signaling

Abstract

The students will obtain an overview about the current topics of research in insulin signaling and how it impacts on growth, metabolism and cell differentiation. They will learn to design experiments and use techniques necessary to analyze different aspects of insulin signaling, including physiological actions in whole animals as well as in tissue culture. Through lectures and literature seminars, they will learn about the open questions of insulin signaling research and discuss approaches to address these questions experimentally.

In practical lab projects the students will perform physiological in vivo studies as well as biochemical experiments. Finally, they will learn how to present and discuss their data. Student assessment is a graded semester performance based on individual performance in the laboratory, a written exam and the lab data presentation.

Experimental Food Microbiology for Biologists

Abstract

Teaching of basic experimental knowledge for detection and identification of foodborne pathogens in food. Practical experiments were accompanied by theoretical introductions. Students become acquainted with classical and state-of-the-art molecular techniques for the rapid detection of food borne pathogens and experiments in dependence on current research topics of the Laboratory of Food Microbiology.

Objective

Introduction of methods and techniques of food microbiology

Content

Teaching of basic experimental knowledge for detection and identification of foodborne pathogens by applying state-of-the-art techniques as well as modern molecular techniques for the rapid identification of relevant foodborne pathogens.

Lecture notes

Handouts were provided at the start of the course

- Krämer: “Lebensmittel-Mikrobiologie“ (Ulmer; UTB)
- Süssmuth et al.: “Mikrobiologisch-Biochemisches Praktikum“ (Thieme)
Complex Carbohydrates - Biosynthesis, Structure & Function

**Number of participants limited to minimum 2 and maximum 8.**

**Abstract**
In vitro & in vivo experiments will introduce current research on the biosynthesis, structure & function of protein-bound glycans in different pro- and eukaryotic microorganisms.

**Objective**
Participants are familiar with the biosynthesis, structure and function of N-glycans in microorganisms and with the methods for their analysis.

**Content**
- Topics: biosynthesis of asparagine-linked glycans in pro- and eukaryotes; structure of glycans in different organisms; methods to analyse the structure of glycans; function of glycans in protein quality control
- Introductory lectures
- Seminar with presentation and discussion of recent publications
- Experiments that exemplify the current research done in the group

**Plant Volatiles in Plant Insect Interactions**

**Number of participants limited to 16.**

**Abstract**
The course will cover six main topics that will be connected throughout the experimental phase:

1. Plant volatile biosynthesis and classification
2. Insect olfactory physiology
3. Volatile-mediated plant-herbivore interactions
4. Volatile-mediated multiple trophic interactions
5. Manipulation of plant volatile emission by vector-borne disease agents
6. Methods for volatile collection and analysis

**Objective**
The course will cover six main topics that will be connected throughout the experimental phase:

- Experiments that exemplify the current research done in the group
- Seminar with presentation and discussion of recent publications
- Introductory lectures

**Literature**
The recommended literature, including reviews and primary research articles, will be provided during the course.

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**Block Courses in 4th Quarter of the Semester**

**From 1.12.2016 08:00 hr to 23.12.2016 17:00 hr**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>551-0361-00L</td>
<td>Biology of Bryophytes and Ferns</td>
<td>W</td>
<td>6</td>
<td>7</td>
<td>R. Holderegger, A. L. Bergamini</td>
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<td><strong>Abstract</strong></td>
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<td>Bryophytes: Basic knowledge on the morphology, ecology, biogeography</td>
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<td>Ferns: basic knowledge on the life cycle, evolution and ecology of</td>
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<td>ferns; identification of Swiss ferns; field trips.</td>
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<td>Bryophytes: Systematics and morphology of hornworts, liverworts and</td>
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<td>mosses and special themes such as ecology, biogeography, diversity</td>
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<td>and endangerment of byrophytes; one full-day field trip.</td>
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<td>Ferns: Life cycle; evolutionary groups of ferns and fern allies;</td>
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<td>breeding systems, micro- and macroevolution; ecology; full-day and</td>
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<td><strong>Lecture notes</strong></td>
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<td><strong>Literature</strong></td>
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<td>Students have to present a poster on a special theme.</td>
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<td>First and second year courses in Botany and Evolution.</td>
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RNA-Biology

**Number of participants limited to 20.**

**Abstract**
Introduction to the diversity of current RNA-research at all levels from structural biology to systems biology using mainly model systems like S. cerevisiae (yeast), mammalian cells.

**Objective**
The students will obtain an overview about the diversity of current RNA-research. They will learn to design experiments and use techniques necessary to analyze different aspects of RNA biology. Through lectures and literature seminars, they will learn about the burning questions of RNA research and discuss approaches to address these questions experimentally. In practical lab projects the students will work in one of the participating laboratories. Finally, they will learn how to present and discuss their data in an appropriate manner. Student assessment is a graded semester performance based on individual performance in the laboratory, the written exam and the poster presentation.

**Literature**
Documentation and recommended literature will be provided at the beginning and during the course.

**Prerequisites / notice**
The course will be taught in English.

---

Parallels Between Tissue Repair and Cancer

**Number of participants limited to 15.**

**Abstract**
This course aims at the understanding of the cellular and molecular mechanisms underlying tissue repair processes in response to different insults. The focus will be on repair of the skin and the liver. In addition, we will highlight the parallels and differences between tissue repair and cancer.
To learn the cellular and molecular principles underlying tissue repair processes, in particular in the skin and in the liver, and the parallels and differences to cancer. To learn modern technologies in Molecular and Cellular Biology as well as Histology and to use these technologies to study questions related to mechanisms underlying tissue repair and cancer.

This course aims at the understanding of the cellular and molecular mechanisms underlying tissue repair processes in response to different insults. The focus will be on repair of the skin and the liver. In addition, we will highlight the parallels and differences between tissue repair and cancer. Experimental approaches include biochemical studies, molecular and cellular studies using cultured cell lines and primary cells, as well as analysis of murine and human tissues. The course combines practical work with lectures, discussions, project preparations and presentations.

The course contains a lecture part, an experimental part, two determination courses (aquatic invertebrates and algae) and field excursions.

During this course you will get an overview of the world’s typical continental aquatic ecosystems. After this course you will be able to:

- measure and interpret biological and physical data (e.g. during experiments, field work) and present the collected knowledge.
- perform subtomogram averaging, model structures of interest, and generate movies for visualization.
- study the principles of doing research to observe interrelations in aquatic ecosystems.
- resolve their structure in a native state, in 3D, and to
- generate movies for visualization.
- Imaging Bacterial Cells in a Native State by Electron Cryotomography

- cryomicroscope, process raw data, analyze tomograms, perform subtomogram averaging, model structures of interest, and generate movies for visualization.
- Understand the function and evolution of insulin/TOR signaling

- learn how genetic approaches in different organisms contribute to the understanding of human diseases such as cancer

- will get familiarized with reading and discussing research articles

- get a first exposure to current research.

The course combines practical work with lectures, discussions, project preparations and presentations.

The block course consists of

- experiments:
  - Teams of two students each will join research labs to work on current projects focusing on growth regulation in both single-cell eukaryotes (yeast) and multicellular animals (Drosophila). The students will present their projects and results to their colleagues.

- lectures on growth regulation in yeast and Drosophila.

- journal clubs to discuss recent literature.

- Lecture handouts

- Original research articles will be discussed during the course.

- Imaging Bacterial Cells in a Native State by Electron Cryotomography

- cryomicroscope, process raw data, analyze tomograms, perform subtomogram averaging, model structures of interest, and generate movies for visualization.

- To learn the cellular and molecular principles underlying tissue repair processes, in particular in the skin and in the liver, and the parallels and differences to cancer. To learn modern technologies in Molecular and Cellular Biology as well as Histology and to use these technologies to study questions related to mechanisms underlying tissue repair and cancer.

- The course aims at the understanding of the cellular and molecular mechanisms underlying tissue repair processes in response to different insults. The focus will be on repair of the skin and the liver. In addition, we will highlight the parallels and differences between tissue repair and cancer. Experimental approaches include biochemical studies, molecular and cellular studies using cultured cell lines and primary cells, as well as analysis of murine and human tissues. The course combines practical work with lectures, discussions, project preparations and presentations.

- The course contains a lecture part, an experimental part, two determination courses (aquatic invertebrates and algae) and field excursions.

- During this course you will get an overview of the world’s typical continental aquatic ecosystems. After this course you will be able to:
  - measure and interpret biological and physical data (e.g. during experiments, field work) and present the collected knowledge.
  - perform subtomogram averaging, model structures of interest, and generate movies for visualization.
  - understand the function and evolution of insulin/TOR signaling
  - learn how genetic approaches in different organisms contribute to the understanding of human diseases such as cancer
  - will get familiarized with reading and discussing research articles
  - get a first exposure to current research.

- The course combines practical work with lectures, discussions, project preparations and presentations.

- The block course consists of
  - experiments:
    - Teams of two students each will join research labs to work on current projects focusing on growth regulation in both single-cell eukaryotes (yeast) and multicellular animals (Drosophila). The students will present their projects and results to their colleagues.
  - lectures on growth regulation in yeast and Drosophila.
  - journal clubs to discuss recent literature.

- Lecture handouts

- Original research articles will be discussed during the course.

- Imaging Bacterial Cells in a Native State by Electron Cryotomography

- cryomicroscope, process raw data, analyze tomograms, perform subtomogram averaging, model structures of interest, and generate movies for visualization.

- To learn the cellular and molecular principles underlying tissue repair processes, in particular in the skin and in the liver, and the parallels and differences to cancer. To learn modern technologies in Molecular and Cellular Biology as well as Histology and to use these technologies to study questions related to mechanisms underlying tissue repair and cancer.

- The course aims at the understanding of the cellular and molecular mechanisms underlying tissue repair processes in response to different insults. The focus will be on repair of the skin and the liver. In addition, we will highlight the parallels and differences between tissue repair and cancer. Experimental approaches include biochemical studies, molecular and cellular studies using cultured cell lines and primary cells, as well as analysis of murine and human tissues. The course combines practical work with lectures, discussions, project preparations and presentations.

- The course contains a lecture part, an experimental part, two determination courses (aquatic invertebrates and algae) and field excursions.

- During this course you will get an overview of the world’s typical continental aquatic ecosystems. After this course you will be able to:
  - measure and interpret biological and physical data (e.g. during experiments, field work) and present the collected knowledge.
  - perform subtomogram averaging, model structures of interest, and generate movies for visualization.
  - understand the function and evolution of insulin/TOR signaling

**Block Courses during Semester Break**
### Analysis of Human T and B Cell Responses to Infectious Agents

**Number** 551-1143-00L  
**Type** W  
**ECTS** 6 credits  
**Hours** 7G  
**Lecturers** A. Lanzavecchia  

**Abstract**  
Students actively participate in ongoing research projects on the analysis of human T and B cell response to pathogens and vaccines. They will be tutored in small groups by doctoral students and postdocs. In a lecture series, the theoretical background for the projects will be provided and the students will have the opportunity to present their projects and discuss recent publications.

**Objective**  
To learn current methodologies in human immunology through experimental work in the lab. To learn current concepts through lectures and discussion of original papers. Requirement for obtaining the credit points: oral presentation of the research project in a ppt format.

**Content**  
The course will consist of a series of lectures, assay assignments, project development and discussion workshops, and 2 and a half week of lab work with different mammalian cell systems embedded in real life research projects. At the end of the course students will take an exam consisting of questions on the topic of the lectures and workshops. It is expected that students will be able to apply the knowledge to concrete problems.

**Prerequisites / notice**  
Participation in one of the following projects will be possible:

- Projects of the Glockshuber group:
  - Purification, biophysical characterization and structure determination of enzymes required for disulfide bond formation in the periplasm of Gram-negative bacteria.
  - Identification of intermediates in the aggregation of the human Abeta peptide

- Experimental work on these projects involves:
  - Molecular cloning, recombinant protein production in E. coli and protein purification
  - Protein crystallization
  - Thermodynamic and kinetic characterization of conformational changes in proteins and protein-ligand interactions by fluorescence and circular dichroism spectroscopy
  - Analysis of rapid reactions by stopped-flow fluorescence
  - Negative-stain electron microscopy
  - Light scattering

- Projects of the Weber-Ban group:
  - Generation and purification of site-directed variants of the E. coli ClpA/P protease and chaperone-proteasome complexes from other organisms, their biophysical characterization, including rapid kinetics by stopped-flow methods, ATPase activity measurements, negative-stain electron microscopy and light scattering

Lecture notes: No script  
Literature: Literature related to the individual projects will be provided on the first day of the course.  

#### Genomic and Genetic Methods in Cell and Developmental Biology

**Number** 551-1709-00L  
**Type** W  
**ECTS** 6 credits  
**Hours** 7G  
**Lecturers** A. Wutz, C. Ciaudo, M. Köpf, T. Schroeder, G. Schwank  

**Abstract**  
This course aims to provide students with a comprehensive overview of mammalian developmental biology and stem cell systems both on the theoretical as well as the experimental level. Centering the course on genetic and genomic methods engages the students in contemporary research and prepares for future studies in the course of semester and master projects.

**Objective**  
- Understanding mammalian development  
- Introduction to stem cells systems  
- Working with cultured cells  
- Translational aspects of mammalian cell biology

**Content**  
The course will consist of a series of lectures, essay assignments, project development and discussion workshops, and 2 and a half week of lab work with different mammalian cell systems embedded in real life research projects. At the end of the course students will take an exam consisting of questions on the topic of the lectures and workshops. It is expected that students will be able to apply the knowledge to concrete problems.

#### GESS Science in Perspective

- **see GESS Science in Perspective: Type A: Enhancement of Reflection Capability**
- **see GESS Science in Perspective: Language Courses ETH/ZH**

**Recommended GESS Science in Perspective (Type B) for D-BIOL.**

### Biology Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>W</th>
<th>E-</th>
<th>Z</th>
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<tbody>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
<td>Eligible for credits</td>
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<td>O</td>
<td>Compulsory</td>
<td>Recommended, not eligible for credits</td>
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<td>W+</td>
<td>Eligible for credits and recommended</td>
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<td>Courses outside the curriculum</td>
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<td>practical/laboratory course</td>
<td></td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS  European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Biology Teaching Diploma

The programme "Teaching Diploma, Two Subjects in One-Step Procedure" will not be offered anymore since Autumn Semester 2010. Therefore new matriculations are no longer possible. The courses offered below are valid only for students who have registered before.

Detailed information on the programme at: www.didaktischeausbildung.ethz.ch

► Biology as First Subject

►► Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
</tbody>
</table>

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective

- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction
- Understand research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

Prerequisites / notice

För eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
</tbody>
</table>

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

Number of participants limited to 30.

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract

The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

Objective

- Understanding research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
</tbody>
</table>

Number of participants limited to 30.

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract

Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objective

- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Number of participants limited to 20.

The successful completion of both course no. 851-0240-00L "Menschliches Lernen (EW 1)" and course no. 851-0238-01L "Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)" is a necessary prerequisite for this course.

Abstract

In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.

Objective

The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning & Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)

Learning goals include:
- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.
- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.
- Participants can design and conduct a study that is relevant for answering their research question.
- Participants can summarize and evaluate the main results from a study in the field of learning and instruction, with regard to the research question being asked.

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 229 of 1571
551-0961-00L  |  Mentored Work Subject Didactics Biology A  |  O  |  2 credits  |  4A  |  J. Egli
Mentored Work Subject Didactics in Biology for Teaching Diploma, Teaching Diploma Biology as Minor Subject. The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
Themenwahl nach Vereinbarung.

Lecture notes
Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

Prerequisites / notice
Beginn nach Absprache jederzeit möglich, jedoch erst nach Abschluss der Fachdidaktik I und II und nach der Absolvierung allfälliger fachwissenschaftlicher Voraussetzungen.

Die Arbeit sollte vor Beginn des Unterrichtspraktikums abgeschlossen werden.

551-0962-00L  |  Mentored Work Subject Didactics Biology B  |  O  |  2 credits  |  4A  |  J. Egli
Mentored Work Subject Didactics in Biology for Teaching Diploma, Teaching Diploma Biology as Minor Subject and for students upgrading TC to Teaching Diploma. The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
Thematische Schwerpunkte

Lecture notes
Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

Prerequisites / notice
Beginn nach Absprache jederzeit möglich, jedoch erst nach Abschluss der Fachdidaktik I und II und nach der Absolvierung allfälliger fachwissenschaftlicher Voraussetzungen.

Die Arbeit sollte vor Beginn des Unterrichtspraktikums abgeschlossen werden.

551-0971-00L  |  Subject Didactics Biology I  |  O  |  4 credits  |  3G  |  P. Faller
Simultaneous enrolment in Introductory Internship Biology
- course 551-0968-00L - is compulsory.

Abstract
- Basic conditions for tuition (MAR - recognition of Matura certificates - curricula, standards), selection of topics and reduction of the complexity of topics.
- Application of teaching methods and techniques from educational science in biology classes.
- Planning and preparation of lessons.

Objective
- Students can discuss and put into practice in their teaching work the conditions and objectives set out in the regulations governing the school-leaving examination (Matura), the framework curriculum and the conditions and objectives specified by their school.
- They are in a position to select learning objectives and formulate these on the basis of the target level model. They can plan and prepare lessons and can also develop appropriate learning assignments.
- Students can reconstruct specialist contents in didactic terms and develop teaching modules suitable for the different levels from these on the basis of the subject structure and learner requirements.
- They can reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners.
- They can select appropriate media for their work (e.g. school books) and use these. They can employ appropriate experiments.
- The students can use different forms of examination for monitoring performance.
- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.

Content

Lecture notes
Wird laufend in der Vorlesung abgegeben.

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 230 of 1571
**Professional Training (First Subject)**

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**Number** | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
551-0968-00L | Introductory Internship Biology | O | 3 credits | 6P | P. Faller

**Abstract**

During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.

**Objective**

Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

**Content**


**Literature**

Wird von der Praktikumslehrperson bestimmt.

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**Number** | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
551-0966-00L | Teaching Internship Biology | O | 8 credits | 17P | P. Faller

**Abstract**

The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.

**Objective**

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They acquire the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

**Content**


**Literature**

Wird von der Praktikumslehrperson bestimmt.

---

**Number** | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
551-0967-00L | Teaching Internship Biology II | W | 4 credits | 9P | P. Faller

**Abstract**

This is a supplement to the Teaching Internship required to obtain in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.

**Objective**

Students are able to assess in their subject the importance of teaching topics from different angles. They learn and master the teaching trade, they can structure a given lesson topic for a group of learners technically and didactically correctly and they can transfer it into an appropriate learning environment. They manage to find the balance between instruction and openness, so that the learners have both, the necessary freedom and sufficient orientation to acquire actively and a effectively adaptive (expert) knowledge.

**Content**


---

**Number** | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
551-0969-01L | Examination Lesson I Biology | O | 1 credit | 2P | P. Faller

**Abstract**

In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

**Objective**

- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

**Content**


**Lecture notes**

Dokument: Schriftliche Vorbereitung für Prüfungslektionen.

**Prerequisites / notice**

Nach Abschluss der übrigen Ausbildung.

---

**Number** | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
551-0969-02L | Examination Lesson II Biology | O | 1 credit | 2P | P. Faller
Simultaneous enrolment in “Examination Lesson I Biology” (551-0969-01L) is compulsory.

**Abstract**

In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

**Objective**

On the basis of a specified topic, the candidate shows that they are in a position:
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

**Content**

Die Studierenden erfahren das Lektionsthema in der Regel 10 Tage vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten sie Informationen über den Wissensstand der zu unterrichtenden Klasse und können sie vor dem Prüfungstermin besuchen.

Sie erstellen eine Vorbereitung gemäss Anleitung und reichen diese 48 Stunden vor dem Prüfungstermin den beiden Prüfungsexperten ein.

Die gehaltene Lektion wird kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/ der Kandidatin über die gehaltene Lektion im Rahmen eines kurzen Kolloquiums.

**Lecture notes / notice**

Nach Abschluss der Übungen Ausbildung.

---

**Professional Exercises in Biology**

**Type:**

O 2 credits 2U  P. Faller

**Abstract**

Students conduct a series of “classical” biological school experiments and therefore gain practice and experience in this area.

**Objective**

Implementation of Subject Didactics I and II with the focus on conducting biological experiments in schools. This includes finding, testing and further developing suitable protocols for different subject areas of school biology. Working out how to didactically embed the experiments in lessons.

Students can, off the cuff, 12 school experiments (which they have tested themselves), from the different subject areas, and conduct these correctly in technical terms. They can incorporate these experiments in their tuition in a didactically meaningful manner.

**Comments:**

By contrast to the Subject Specialisation 1 and 2 course units, these are “basic tests” and do not involve the implementation of current research topics. The students’ compilations are available in a data archive.

**Content**


2. Die Studierenden führen alle ausgearbeiteten Experimente selber durch.


**Lecture notes**

Hand out of course material.

**Prerequisites / notice**

Der Teil biologische Experimente findet im Rahmen von 7 Halbtagen statt.

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**Number**

**Title**

Specialized Biology Course with an Educational Focus: Teaching Diploma

**ECTS**

6 credits

**Lecturers**

E. Hafen, J. Egli, W.D. Hardt, M. Zwicky

**Abstract**

Specialist aspects of biology are covered from the angle of imparting these to pupils, their historical development, and their significance for the subject, the individual and society.

**Objective**

After successfully completing the module, students should be in a position:
- to call up more in-depth specialist knowledge of biology, covering a wide range of topics, and to impart this to others.
- to conduct more in-depth work on a research topic and to compile a tuition unit based on this topic
- to prepare tuition units involving complex learning matter at a high specialist level which are suitably tailored to the recipients, and to teach these in a manner conducive to learning.

**Performance Assessment:**

Performance is assessed during the course of the entire module, with a final test. Active participation in the colloquia and group seminars is required. The thesis report and an oral presentation have to be completed.

The Specialized Biology Course with an Educational Focus (12 CP) can be acknowledged, in agreement with the advisor of the respective student's elective major, as one of the two obligatory research projects (each 15 CP). In such a case, additional 3 CP must be obtained in another course.

In case of overbooking of the course, students enrolled in the Teaching Diploma in Biology will have priority for registration.

The course is organized jointly with the University of Zurich (Fachbereich Biologie) and is held at the Life Science Zurich Learning Center of the ETH Zurich and the University of Zurich.

**Lecture notes**

Underlagen für den Unterricht werden online mit Hilfe der e-learning Platform OLAT abgegeben.

**Literature**

Literator und Literaturhinweise werden mit der e-learning Platform OLAT abgegeben.

**Prerequisites / notice**

This Course lasts for two semesters. It can be started in autumn or in spring. Booking is only required once.

Performance Assessment:

Performance is assessed during the course of the entire modul, with a final test. Active participation in the colloquia and group seminars is required. The thesis report and an oral presentation have to be completed.

The Specialized Biology Course with an Educational Focus (12 CP) can be acknowledged, in agreement with the advisor of the respective elective major, as one of the two obligatory research projects (each 15 CP). In such a case, additional 3 CP must be obtained in another course.

In case of overbooking of the course, students enrolled in the Teaching Diploma in Biology will have priority for registration.

The course is organized jointly with the University of Zurich (Fachbereich Biologie) and is held at the Life Science Zurich Learning Center of the ETH Zurich and the University of Zurich.

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**Professional Exercises in Biology**

**Type:**

W 6 credits 13A  E. Hafen, J. Egli, M. Zwicky

**Abstract**

Specialised Courses in the Respective Subject with an Educational Focus in Biology for Teaching Diploma.

**Objective**

Specialised aspects of biology are dealt with under consideration of the special needs of persons involved in teaching. The module comprises the parts:

1) Lecture (Tues. 08.00-09.45 hrs)
2) Colloquium (every second Tues. 10.15-12.00 hrs., begins on first lecture day)
3) Seminar with presentation (every second Tues. 10.15-12.00 hrs., begins in second lecture week)
4) Semester thesis in a research group (7 weeks)

**Lecture notes**

Unterlagen für den Unterricht werden online mit Hilfe der e-learning Platform OLAT abgegeben.

**Literature**

Literator und Literaturhinweise werden mit der e-learning Platform OLAT abgegeben.

**Prerequisites / notice**

This Course lasts for two semesters. It can be started in autumn or in spring. Booking is only required once.

Performance Assessment:

Performance is assessed during the course of the entire modul, with a final test. Active participation in the colloquia and group seminars is required. The thesis report and an oral presentation have to be completed.

The Specialized Biology Course with an Educational Focus (12 CP) can be acknowledged, in agreement with the advisor of the respective elective major, as one of the two obligatory research projects (each 15 CP). In such a case, additional 3 CP must be obtained in another course.

In case of overbooking of the course, students enrolled in the Teaching Diploma in Biology will have priority for registration.

The course is organized jointly with the University of Zurich (Fachbereich Biologie) and is held at the Life Science Zurich Learning Center of the ETH Zurich and the University of Zurich.
Demanding biological topics are dealt with under consideration of the special needs of persons involved in teaching. The module:

1) Lecture (Tues. 08.00-09.45 hrs)
2) Colloquium (every second Tues. 10.15-12.00 hrs., begins on first lecture day)
3) Seminar with presentation (every second Tues. 10.15-12.00 hrs., begins in second lecture week)
4) Semester thesis in a research group (3.5 weeks)

Lecture notes

None.

Literature

Specific references will be made available for the individual projects.

Prerequisites / notice

The program of this course represents one half (6 CP) of that of the Specialized Biology Course with an Educational Focus (551-0963-00, 12 CP).

Compulsory Elective Courses

Further course offerings from the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0180-00L</td>
<td>Research Ethics</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>G. Achermann</td>
</tr>
<tr>
<td></td>
<td>Particularly suitable for students of D-BIOL, D-CHAB, D-HEST</td>
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</tbody>
</table>

Abstract

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective

The main goal of this course is to enhance the student’s ability to:
- recognize and identify ethical issues and conflicts.
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers
The course represents an introduction to recent research into student learning on the conceptual foundations of modern biology, together with pedagogical methods associated with effective instruction and its valuation. Students will be involved in active research into conceptual and practical issues involved in biology education and methods to discover student preconceptions.

Content

(1) Theories and concepts of inter- and transdisciplinary research
(2) The specific challenges of inter- and transdisciplinary research
(3) Involving stakeholders
(4) Collaborating disciplines
(5) Exploration of tools and methods
(6) Analysing participants' projects to improve inter- and transdisciplinary elements

Literature

Literature will be made available to the participants

Prerequisites / notice

The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.

701-1551-00L Environmental Governance

| Abstract | The course addresses environmental policies, focusing on new steering approaches, which are generally summarized as environmental governance. The course also provides students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples. |
| Objective | To understand how an environmental problem may (not) become a policy and explain political processes, using basic concepts and techniques from political science. To analyze the evolution as well as the key elements of environmental governance. To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples. |
| Lecture notes | Lecture slides and additional course material will be provided throughout the semester. |
| Prerequisites / notice | A detailed course schedule will be made available at the beginning of the semester. |
| 701-1551-00L Sustainability Assessment | W 3 credits 2G P. Krüttli, C. E. Pohl |
| Abstract | The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability. The course is seminar-like, interactive. |
| Objective | At the end of the course students should know: - core concepts of sustainable development, and; - the concept of social justice - normatively and empirically - as a core element of social sustainability; - important empirical methods for the analysis and assessment of local / regional sustainability issues. Understand and reflect on: - the challenges of trade-offs between the different goals of sustainable development; - and the respective impacts on individual and societal decision-making. |
| Content | The course is structured as follows: - Overview of rationale, objectives, concepts and origins of sustainable development; - Importance and application of sustainability in science, politics, society, and economy; - Sustainable (local / regional) development in different national / international contexts; - Analysis and evaluation methods of sustainable development with a focus on social justice; - Trade-offs in selected examples. |
| Lecture notes | Handouts. |
| Literature | Selected scientific articles & book chapters |

701-0916-00L Learning and Teaching Biology

| Abstract | This course represents an introduction to recent research into student learning on the conceptual foundations of modern biology, together with pedagogical methods associated with effective instruction and its valuation. Students will be involved in active research into conceptual and practical issues involved in biology education and methods to discover student preconceptions. |
| Objective | Provides an overview on student's learning and shows ways to make the classroom experience more engaging and effective for students. Students will learn to produce a research-based paper on a project they work on during the course. |
## Biology as Second Subject

### Subject Didactics in Biology

#### Course Information

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0971-00L</td>
<td>Subject Didactics Biology I • Simultaneous enrolment in Introductory Internship Biology</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>P. Faller</td>
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<tr>
<td></td>
<td>- Basic conditions for tuition (MAR - recognition of Matura certificates - curricula, standards), selection of topics and reduction of the complexity of topics.</td>
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<td></td>
<td>- Application of teaching methods and techniques from educational science in biology classes.</td>
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<td></td>
<td>- Planning and preparation of lessons.</td>
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<td></td>
<td>- Students can discuss and put into practice in their teaching work the conditions and objectives set out in the regulations governing the school-leaving examination (Matura), the framework curriculum and the conditions and objectives specified by their school.</td>
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<td>- They are in a position to select learning objectives and formulate these on the basis of the target level model. They can plan and prepare lessons and can also develop appropriate learning assignments.</td>
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<td>- Students can reconstruct specialist contents in didactic terms and develop teaching modules suitable for the different levels from these on the basis of the subject structure and learner requirements.</td>
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<td>- They can reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners.</td>
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<td>- They can select appropriate media for their work (e.g. school books) and use these. They can employ appropriate experiments.</td>
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<td>- They can provide different forms of examination for monitoring performance.</td>
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<td>- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.</td>
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<td>The objective is for the students:</td>
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<td>- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.</td>
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<td>- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.</td>
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<td>- The students can use different forms of examination for monitoring performance.</td>
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</table>

#### Content


#### Prerequisites / notice

- Studierende müssen LE zusammen mit dem Einführungspraktikum - LE 551-0968-00L - belegen.

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#### Mentored Work Subject Didactics Biology A

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>551-0961-00L</td>
<td>Mentored Work Subject Didactics Biology A • Mentored Work Subject Didactics in Biology for Teaching Diploma, Teaching Diploma Biology as Minor Subject</td>
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<td>The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.</td>
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<td>The objective is for the students:</td>
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</tbody>
</table>

#### Content

- Themenwahl nach Vereinbarung.
- Reflexion über Themen aus allen biologiepezifischen Bereichen des Unterrichts.

#### Literature

- Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

#### Prerequisites / notice

- Beginn nach Absprache jederzeit möglich, jedoch erst nach Abschluss der Fachdidaktik I und II und nach der Absolvierung allfälliger fachwissenschaftlicher Voraussetzungen.

Die Arbeit soll vor Beginn des Unterrichtspraktikums abgeschlossen werden.

Allfällige fachwissenschaftliche Auflagen müssen alle erfüllt sein, bevor mit der Mentorierten Arbeit begonnen werden kann.

---

#### Mentored Work Subject Didactics Biology B

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<th>Number</th>
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<tr>
<td>551-0962-00L</td>
<td>Mentored Work Subject Didactics Biology B • Mentored Work Subject Didactics in Biology for Teaching Diploma, Teaching Diploma Biology as Minor Subject and for students upgrading TC to Teaching Diploma</td>
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<td>4A</td>
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<td>The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.</td>
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<td>The objective is for the students:</td>
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<td>- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.</td>
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</tbody>
</table>
ECTS Lecturers

The students collect experiences in the direction of education, dealing with learners, class supervision, and the fachwissenschaftlicher Voraussetzungen.

Prerequisites / notice

Beginn nach Absprache jederzeit möglich, jedoch erst nach Abschluss der Fachdidaktik und der Absolvierung allfälliger fachwissenschaftlicher Voraussetzungen.

Die Arbeit sollte vor Beginn des Unterrichtspraktikums abgeschlossen werden.

Allfällige fachwissenschaftliche Auflagen müssen alle erfüllt sein, bevor mit der Mentorierten Arbeit begonnen werden kann.

Professional Training in Biology

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>551-0965-00L</td>
<td>Teaching Internship Including Examination Lessons</td>
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<td>9P</td>
<td>P. Faller</td>
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<td></td>
<td>Biology for TC and Teaching Diploma Biology as Minor</td>
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<td>Subject. Repetition of the Teaching Internship is</td>
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<td>excluded even if Examination Lessons are to be</td>
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<td>repeated.</td>
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</table>

Abstract

Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Objective

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content

The students collect experiences in the direction of education, dealing with learners, class supervision, and the fachwissenschaftlicher Voraussetzungen.

Prerequisites / notice

Beginn nach Absprache jederzeit möglich, jedoch erst nach Abschluss der Fachdidaktik und der Absolvierung allfälliger fachwissenschaftlicher Voraussetzungen.

The courses below are only available for students with additional admission requirements.

Course Units for Additional Admission Requirements

The courses below are only available for students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
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<tr>
<td>551-0980-00L</td>
<td>Anthropology (University of Zurich)</td>
<td>E-</td>
<td>3</td>
<td>6G</td>
<td>University lecturers</td>
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<td>No enrolment to this course at ETH Zurich. Book the</td>
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<td>corresponding module directly at UZH. UZH Module</td>
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<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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</table>

Abstract

Genetics, fossil remains, comparative anatomy and behavioral research prove the affiliation of humans to primates. This mammalian order represents variations of a single theme.

The main adaptations and the critical steps of phylogeny are presented.

Objective

Upon successfully completing of the module the students can:
- interpret the main features of primates and especially of fossil hominids in the evolutionary and functional context;
- explain the genetic, phenetic and cultural diversity of modern human populations as the result of evolutionary processes;
- recognize similarities and differences in the behavior and the cognitive lines from humans and animals, in particular monkeys;
- explain why cultural evolution occurs only in humans;
- discuss the question "What are human beings?" from an evolutionary biological perspective.

376-0151-00L Anatomy and Physiology I

Abstract

Basic knowledge of the anatomy and physiology of tissues, of the embryonal and postnatal development, of the basic terminology of pathology, the neuro-muscular system, the cardiovascular system and the respiratory system.

Objective

Basic knowledge of human anatomy and physiology and basics of clinical pathophysiology.

Data: 06.11.2018 12:57
Autumn Semester 2016
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Short overview of human anatomy, physiology and general pathology.

Anatomy and Physiology I (fall term):
Basics of cytology, histology, embryology, general pathology; nervous system, muscles, cardiovascular system, respiratory system

Anatomy and Physiology II (spring term):
digestive system, kidney and urinary tract, endocrine system, skin, thermoregulation, sensory organs, male and female reproductive system, pregnancy and child birth.

Lecture notes

Literature
Anatomie:
Schiebler TH, Korf H-W: Anatomie (10. vollständig überarbeitete Auflage)
Steinkopff / Springer, Heidelberg 2007

Martini FH, Timmons MJ, Tallitsch RB. Human Anatomy

Physiologie:

Prerequisites /
Voraussetzungen: 1. Jahr, naturwissenschaftlicher Teil

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<tr>
<th>Key for Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS
European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
The students gain a good understanding of fundamental aspects of pest management in agroecosystems. They will have the ability to assess options for action in view of requirements from the economy, the ecology and the society. Further, they will learn to perform searches on relevant issues in pest management, and to critically evaluate case studies.

### Evolutionary Genetics

**Number:** 701-2413-00L

**Title:** Evolutionary Genetics

- **Type:** O
- **ECTS:** 6 credits
- **Hours:** 4V
- **Lecturers:** T. Städler, A. Widmer, P. C. Brunner, M. C. Fischer

**Abstract:** The concept course ‘Evolutionary Genetics’ consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

**Objective:** The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods and explanatory power of evolutionary genetics.

**Content:** Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory; Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding, effects on fitness; Fisher’s fundamental theorem. 

**Lecture notes**

- Handouts

**Literature**


**Prerequisites / notice**

There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.

---

**Plant Ecology**

**Number:** 701-0323-00L

**Title:** Plant Ecology

- **Type:** O
- **ECTS:** 3 credits
- **Hours:** 2V
- **Lecturers:** S. Güsewell, J. Levine

**Abstract:** This class focuses on ecological processes involved with plant life, mechanisms of plant adaptation, plant-animal and plant-soil interactions, plant strategies and implications for the structure and function of plant communities. The discussion of original research examples familiarises students with research questions and methods; they learn to evaluate results and interpretations.

**Objective:** Students will be able to:
- propose methods to study ecological processes involved with plant life, and how these processes depend on internal and external factors;
- analyse benefits and costs of plant adaptations;
- explain plant strategies with relevant traits and trade-offs;
- explain and predict the assembly of plant communities;
- explain implications of plant strategies for animals, microbes and ecosystem functions;
- evaluate studies in plant ecology regarding research questions, assumptions, methods, as well as the reliability and relevance of results.

**Content:** Plants represent the matrix of natural communities. The structure and dynamics of plant populations drives the function of ecosystems. This course presents essential processes and plant traits involved with plant life. We focus on research questions that have been of special interest to plant ecologists as well as current topical questions. We use original research examples to discuss how ecological questions are studied and how results are interpreted.

- Growth: what determines the production of a plant?
- Nutrients: consumption or recycling; opposite strategies and feedbacks on soils;
- Clonality: collaboration and division of labour in plants;
- Plasticity: benefits and costs of plant intelligence;
- Flowering and pollination: how expensive is sex?
- Seed types, dispersal, seed banks and germination: strategies and trade-offs in the persistence of plant populations;
- Development and structure of plant populations;
- Stress, disturbance and competition as drivers of different plant strategies;
- Herbivory: plant-animal feedbacks and functioning of grazing ecosystems
- Fire: impacts on plants, vegetation and ecosystems.
- Plant functional types and rules in the assembly of plant communities.

**Lecture notes**

- Handouts and further reading will be available electronically at the beginning of the semester.

**Prerequisites / notice**

- General knowledge of plant biology
- Basic knowledge of plant systematics
- General ecological concepts

### System-Oriented Management of Herbivore Insects

**Number:** 751-4801-00L

**Title:** System-Oriented Management of Herbivore Insects I

- **Type:** W
- **ECTS:** 2 credits
- **Hours:** 2G
- **Lecturers:** D. Mazzi

**Abstract:** The focus is on the potential to assess strategies and tactics of pest management, taking into account the demands from the economy, the environment and the society. Significant agricultural approaches will be explained using practical examples, including prevention using natural resources, surveillance and forecasting, resistance management, as well as product registration, incl. ecotoxicology.

**Objective:** The students gain a good understanding of fundamental aspects of pest management in agroecosystems. They will have the ability to assess options for action in view of requirements from the economy, the ecology and the society. Further, they will learn to perform searches on relevant issues in pest management, and to critically evaluate case studies.

**Lecture notes**

- Literature

**Prerequisites / notice**

Active participation in the discussions is a prerequisite for this course.

---

**Research Seminar: Ecological Genetics**

**Number:** 701-1409-00L

**Title:** Research Seminar: Ecological Genetics

- **Type:** W
- **ECTS:** 2 credits
- **Hours:** 1S
- **Lecturers:** A. Widmer, S. Fior

**Abstract:** In this research seminar we will critically discuss current topics in Ecological Genetics using publications from the leading scientific journals in this field.

**Objective:** It is our aim that participants gain insight into the current research topics and knowledge available in Ecological Genetics and learn to critically assess and appreciate scientific publications in this field.

**Lecture notes**

- Literature

**Prerequisites / notice**

Active participation in the discussions is a prerequisite for this course.

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**Ecology of Anthropogenic Habitats**

**Number:** 551-1703-00L

**Title:** Ecology of Anthropogenic Habitats

- **Type:** W
- **ECTS:** 2 credits
- **Hours:** 1V
- **Lecturers:** D. Ramseier

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**Data: 06.11.2018 12:57**

**Autumn Semester 2016**

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The focus will be on agro-ecology and ecology of urban habitats. Both experience frequent disturbances, specific chemical influences, and extreme climatic conditions. Additionally, in urban habitats edaphic conditions are difficult as well. Turnover of species diversity and composition are higher, both locally and temporary, compared to natural conditions at comparable sites.

Knowledge of agro-ecosystems and urban ecosystems; their origin, ecosystem services, mechanisms and importance for the maintenance of biodiversity.

701-1441-00L

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Exercises</th>
<th>Literature</th>
</tr>
</thead>
</table>

Abstract
The online course ALPEC0le provides a global overview of the complex ecosystems of mountain regions, and of their great diversity of habitats and organisms. The course is interdisciplinary and the various approaches are designed to help understand the past, present and future of mountain ecosystems.

Objective
Knowledge of alpine environments worldwide and their ecology

Content
The online course is subdivided into:
- 5 lessons on abiotic factors: geology, soils and their forming processes, climate, and disturbance factors
- 12 lessons on plants: diversity, patterns and processes, treelines, water & nutrients, carbon cycle, atmospheric influences, sexual and clonal reproduction, and one specific lesson on aquatic environments
- 5 lessons on animals: habitats and adaptations, origin of species, food ecology and impact of domestic livestock
- 3 lessons on landscape evolution: Quaternary paleoenvironments, methods like radiocarbon dating, pollen records, dendrochronology, stable isotopes, and historical data
- 1 lesson on global change

Students can also follow a virtual walk through alpine areas where context-based information on alpine environments can be accessed. Moreover, all major alpine areas of the world can be selected on a map and then informative pictures of those landscapes and faunistic and floristic inhabitants will be shown.

Prerequisites
Online exercises and tests allow to test the learned matter.

Literature
Selected required readings (peer reviewed literature, selected book chapters). Optional recommended readings with additional information.

751-5121-00L

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<td>Insect Ecology</td>
<td>W 2</td>
<td>2V</td>
<td>R. R. Kariyat Ramachandran, C. De Moraes, M. Mescher</td>
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</table>

Abstract
This is an introductory course in insect ecology. Students will learn about the ways in which insects interact with and adapt to their abiotic & biotic environments and their roles in diverse ecosystems. The course will entail lectures, outside readings, and critical analysis of contemporary literature.

Objective
Students completing this course should become familiar with the application of ecological principles to the study of insects, as well as major areas of inquiry in this field. Highlighted topics will include insect behavior, chemical and sensory ecology, physiological responses to biotic and abiotic stressors, plant-insect interactions, community and food-web dynamics, and disease ecology. The course will emphasize insect evolution and adaptation in the context of specific interactions with other organisms and the abiotic environment.

Content

Prerequisites
Online course and seminar

Literature
Provided to students through ILIAS

Online exercises and tests allow to test the learned matter.

401-0625-01L

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Exercises</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0625-01L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W 5</td>
<td>2V+1U</td>
<td>L. Meier</td>
</tr>
</tbody>
</table>

Abstract

Objective
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content

Prerequisites
Online course and seminar

Literature

401-0649-00L

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Exercises</th>
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</thead>
<tbody>
<tr>
<td>401-0649-00L</td>
<td>Applied Statistical Regression</td>
<td>W 5</td>
<td>2V+1U</td>
<td>M. Detting</td>
</tr>
</tbody>
</table>

Abstract
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content
The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

Prerequisites
A script will be available.

Literature
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

701-0301-00L

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Exercises</th>
<th>Literature</th>
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</thead>
<tbody>
<tr>
<td>701-0301-00L</td>
<td>Applied Systems Ecology</td>
<td>W 3</td>
<td>2V</td>
<td>D. Schröter, A. Gessler</td>
</tr>
</tbody>
</table>

Abstract
This course provides the ecological systems’ knowledge needed to question applied solutions to current environmental issues. Our central aim is to balance participants’ respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water.
At the end of the course...

...you know how to structure your inquiry and how to proceed the analysis when faced with a complex environmental issue. You can formulate the relevant questions, find answers (supported by discussions, input from the lecturers and the literature), and you are able to present your conclusions clearly and cautiously.

...you understand the complexity of interactions and structures in ecosystems. You know how ecosystem processes, functions and services interact and feed back across multiple spatio-temporal scales (in general, plus in depth case examples).

...you understand that biodiversity and the interaction between organisms are an integral part of ecosystems. You are aware that the link between biodiversity and process/function/service is rarely fully understood. You know how to honestly deal with this lack of understanding and can nevertheless find, critically analyse and communicate solutions.

...you understand the importance of ecosystem services for society.

...you have an overview of the methods of ecosystem research and have a deeper insight into some of them, e.g. ecosystem observation, manipulation and modelling.

...you have reflected on ecology as a young discipline at the heart of significant applied questions.

This course provides the ecological systems\' knowledge needed to question applied sustainability solutions. We will critically assess the complexity of current environmental issues, illustrating basic ecological concepts and principles. Our central aim is to balance participants\' respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water.

The course is structured around four major topical areas: (1) Integrated Water Management -- Green infrastructure (land management options) as an alternative to engineered solutions (e.g. large reservoirs) in flood and drought management; (2) Fire dynamics, the water cycle and biodiversity -- The surprising dynamics of species life cycles and populations in arid landscapes; (3) Rewilding, e.g. re-introducing apex predators (e.g. wolves), or large ungulates (e.g. bisons) in protected areas -- A nature conservation trend with counterintuitive effects; (4) Coupling of aquatic and terrestrial systems: carbon, nitrogen and phosphorus transfers of global importance on landscape scale.

The course combines elements of a classic lecture, group discussions and problem based learning. It is helpful, but not essential to be familiar with the \"seven stages\" method (see e.g. course 701-0352-00L \"Analysis and Assessment of Environmental Sustainability\" by Christian Pohl et al.).

The course provides the first part of an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

Note: This part builds on \"Using R... (Part I),\" but can be taken independently if the basics of R are already known.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

The course covers the following topics:
- Elements of the R language: control structures (if, else, loops), lists, overview of R objects, attributes of R objects;
- More on R functions;
- Applying functions to elements of vectors, matrices and lists;
- Object oriented programming with R: classes and methods;
- Tailoring R: options;
- Extending basic R: packages.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Note: Part I of UsingR is complemented and extended by Part II, which is offered during the second part of the semester and which can be taken independently from Part I.

Choose the course \"Using R for Data Analysis and Graphics\" and follow the instructions for registration.

The students will be able to use the software R for simple data analysis.

The course provides the second part of an introduction to the statistical software R for scientists. Topics are data generation and selection, graphical functions, important statistical functions, types of objects, models, programming and writing functions.

Note: This part builds on \"Using R... (Part I),\" but can be taken independently if the basics of R are already known.

Part II of the course builds on part I and covers the following additional topics:
- Elements of the R language: control structures (if, else, loops), lists, overview of R objects, attributes of R objects;
- More on R functions;
- Applying functions to elements of vectors, matrices and lists;
- Object oriented programming with R: classes and methods;
- Tailoring R: options;
- Extending basic R: packages.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Note: Part II of UsingR is complemented and extended by Part II, which is offered during the second part of the semester and which can be taken independently from Part II.
Prerequisites / notice

Basic knowledge of R equivalent to "Using R .. (part 1)" ( = 401-6215-00L ) is a prerequisite for this course.

The course resources will be provided via the Moodle web learning platform. Please login (with your ETH (or other University) username-password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145

Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

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**751-4504-00L**  
**Plant Pathology I**  
*W*  
2 credits  
2G  
B. McDonald

**Abstract**

Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems.

**Objective**

Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems.

**Content**

Course description: Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems.

Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

Lecture Topics and Tentative Schedule

**Week 1**  
No Lecture: First day of autumn semester

**Week 2**  
The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nematode attack strategies and types of damage.

**Week 3**  

**Week 4**  

**Week 5**  
Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.

**Week 6**  
Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, preformed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.

**Week 7**  
Pisatin and pisatin demethylease. Local and systemic acquired resistance, signal molecules.

**Week 8**  
Pathogen effects on food quality and safety.

**Week 9**  
Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics, including resistance, physiology, density, uniformity.

**Week 10**  
Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.

**Week 11**  
Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.

**Week 12**  
Strategies for minimizing disease risks: principles of disease control and management.

**Week 13**  
Disease control strategies: economic thresholds, physical control methods.

**Week 14**  
Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

**Lecture notes**

Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.

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**636-0017-00L**  
**Computational Biology**  
*W*  
4 credits  
3G  
T. Stadler, C. Magnus

**Abstract**

The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.

**Objective**

Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:

* stochastic models in molecular evolution  
* phylogenetic & phylodynamic inference  
* maximum likelihood and Bayesian statistics

Attendees will apply these concepts to a number of applications yielding biological insight into:

* epidemiology  
* pathogen evolution  
* macroevolution of species

**Content**

The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

**Lecture notes**

Slides of the lecture will be available online.

https://www.bsse.ethz.ch/cevo/education/cb-materials.html
Students will analyze experimental evolution literature covering a wide range of questions, species and types of analysis and will lead discussions of this literature. Students will develop a written project proposal for a novel evolution experiment (or a novel analysis of a published experiment) to address an unanswered question and will also deliver an oral presentation of the project proposal.

Objective
1. Become familiar with a diverse sample of experimental evolution literature.
2. Gain understanding of the strengths and limitations of experimental evolution for addressing evolutionary questions relative to other forms of evolutionary analysis, and
3. Gain the ability to effectively design and analyze evolution experiments that address fundamental or applied questions in evolutionary biology.

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.
Experimental evolution is a powerful and increasingly prominent approach to investigating evolutionary processes. Students will analyze experimental evolution literature covering a diverse range of topics, species and types of analysis and will lead discussions of this literature. Students will develop a written project proposal for a novel evolution experiment (or a novel analysis of a published experiment) to address an unanswered question and will also deliver an oral presentation of the project proposal. Evaluation will be based on a combination of participation in and leadership of literature discussions, in-class exams, and oral and written presentations of the project proposal.

Prerequisites / notice

701-0245-00 Introduction to Evolutionary Biology (or equivalent).

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0313-00L</td>
<td>Microbiology (Part I)</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pilhofer</td>
</tr>
<tr>
<td>551-0309-00L</td>
<td>Concepts in Modern Genetics</td>
<td>W</td>
<td>6 credits</td>
<td>4V</td>
<td>Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voinnet</td>
</tr>
</tbody>
</table>

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel.

Elective Major: Neurosciences

Compulsory Concept Courses

<table>
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<tr>
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<tbody>
<tr>
<td>376-1305-10L</td>
<td>Neurobiology</td>
<td>O</td>
<td>6 credits</td>
<td>4V</td>
<td>M. E. Schwab, E. Stoeckli, L. Filli, K. A. Martin, further lecturers</td>
</tr>
</tbody>
</table>

Development of the nervous system (NS): the adult NS, plasticity and regeneration, sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, diseases of the NS.

Overview of normal development, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.
Content
Development: Early development of the nervous system, cellular level, nerve fiber growth, building of neuronal networks; biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes
Structure, Plasticity and Repair of the Nervous System (376-1305-01L); Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

Literature
Development of the Nervous System (376-1305-00L); Lecture notes will be provided on OLAT https://www.olat.uzh.ch/olat/dmn/
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

To understand the basic concepts underlying perceptual, motor and cognitive functions.

The colloquium in Neuroinformatics is a series of lectures given by invited experts. The lecture topics reflect the current themes in neurobiology and neuromorphic engineering that are relevant for our Institute.

The topics depend heavily on the invited speakers, and thus change from week to week.

Since we are all experts on consciousness, we expect active participation and discussions!

Different national and international scientific guests are invited to present and discuss their actual scientific results. For students: Critical discussion of current research. Students aiming at getting a credit point for this colloquium choose one topic and write a critical essay on the presented research topic.

Current national and international scientific guests are invited to present and discuss their actual scientific results. To exchange scientific knowledge and data and to promote communication and collaborations among researchers.

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 246 of 1571
Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. We will read both original papers and explore the conceptual links between them and discuss the 'sociology' of science, the pursuit of basic science questions over a century of research. It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote.

Abstract

Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Unusually, we will explore these areas of research by reading the original publications, instead of reading someone else's digested summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and linked together with related findings from many different scientists, generate the current views of mechanism and structure of the nervous system. To give one concrete example, in 1890 Roy and Sherrington showed that there was a neural activity-dependent regulation of blood flow in the brain. One hundred years later, Ogawa discovered that they could use Nuclear Magnetic Resonance (NMR) to measure a blood oxygen-level dependent (BOLD) signal, which they showed was neural activity-dependent. This discovery led to the development of human functional Magnetic Resonance Imaging (fMRI), which has revolutionized neuropsychology and neuropsychiatry. We will read both these original papers and explore the conceptual links between them and discuss the sociology of science, which in this case, the pursuit of basic science questions over a century of research, led to an explosion in applications. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. Each week the course members will be given original papers to read for homework, they will have to write a short abstract for each paper. We will then meet weekly with the course leader (KACM) and an assistant for an hour-or-so long interactive seminar. An intimate knowledge of the papers will be assumed so that the discussion does not center simply on an explication of the contents of the papers. Assessment will in the form of a written exam in which the students will be given a paper and asked to write a short abstract of the contents.

Content

It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote. Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Unusually, we will explore these areas of research by reading the original publications, instead of reading someone else's digested summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and by many different scientists, linked together to generate the current view of mechanism and structure. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. To give one concrete example, in 1890 Roy and Sherrington showed that there was a neural activity-dependent regulation of blood flow in the brain. One hundred years later, Ogawa discovered that they could use Nuclear Magnetic Resonance (NMR) to measure a blood oxygen-level dependent (BOLD) signal, which they showed was neural activity-dependent. This discovery led to the development of human functional Magnetic Resonance Imaging (fMRI), which has revolutionized neuropsychology and neuropsychiatry. We will read both these original papers and explore the conceptual links between them and discuss the sociology of science, which in this case, the pursuit of basic science questions over a century of research, led to an explosion in applications. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. Each week the course members will be given original papers to read for homework, they will have to write a short abstract for each paper. We will then meet weekly with the course leader (KACM) and an assistant for an hour-or-so long interactive seminar. An intimate knowledge of the papers will be assumed so that the discussion does not center simply on an explication of the contents of the papers. Assessment will be done continuously as the individual students are asked to explain a figure, technique, or concept.

551-1145-00L Viral and non-Viral Vectors for Human Gene-Therapy - W 2 credits 3V
from Pathogens to Safe Medical Applications

Objective

Knowledge of important viral and non-viral vector systems.
Knowledge of application in human diseases.
Knowledge of limiting factors.

Content

Basic aspects of virology, the viral mechanisms for transfer of genetic material into cells, different vector-systems and target cells, animal models, specific applications for inborn diseases of the immune system and of metabolism, adverse effects, and new developments of vector systems will be taught.

Computational Biology W 4 credits 3G

Objective

Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:
* stochastic models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics

Content

The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. H1N1, HIV, Influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

Lecture notes

Slides of the lecture will be available online.
https://www.bsse.ethz.ch/cevo/education/cb-materials.html
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

### Lectures

#### Ectopic Major: Microbiology and Immunology

#### Elective Concept Courses

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<thead>
<tr>
<th>Number</th>
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<tr>
<td>551-0317-00L</td>
<td>Immunology I</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>A. Oxenius, M. Kopf</td>
</tr>
<tr>
<td>551-0309-00L</td>
<td>Concepts in Modern Genetics</td>
<td>W</td>
<td>6 credits</td>
<td>4V</td>
<td>Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voinnet</td>
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<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>U. Kutay, R. I. Enchev, B. Kommann, M. Peter, I. Zemp, further lecturers</td>
</tr>
</tbody>
</table>

#### Prerequisites / notice

- Basic knowledge of cell and molecular biology.
- Basic knowledge of the mechanisms and regulation of an immune response.
- Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming skills will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

#### Literature

- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

#### Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

#### Further lecturers

- F. Allain
- W. U. Kutay
- M. Stoffel, O. Voinnet

#### Notes

- Additional materials will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biolog.ethz.ch)
**551-0313-00L**  Microbiology (Part I)  O  3 credits  2V  W.D. Hardt, L. Ebert, H.M. Fischer, J. Piel, M. Pilhofer

**Abstract**
Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Objective**
This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Content**
Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Lecture notes**
Updated handouts will be provided during the class.

**Literature**
Current literature references will be provided during the lectures.

**Prerequisites / notice**
The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

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**551-0317-00L**  Immunology I  O  3 credits  2V  A. Oxenius, M. Kopf

**Abstract**
Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

**Objective**
Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

**Content**
- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histocompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

**Lecture notes**
Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien".

**Literature**

**Prerequisites / notice**
Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

<table>
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<tr>
<th>Number</th>
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<tr>
<td>551-0223-00L</td>
<td>Immunology III</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>M. Kopf, M. Bachmann, J. Kiselow, A. Lanzavecchia, S. R. Leibundgut, A. Oxenius, R. Spörri</td>
</tr>
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</table>

**Abstract**
This course provides a detailed understanding of
- development of T and B cells
- the dynamics of an immune response during acute and chronic infection
- mechanisms of immunopathology
- modern vaccination strategies

**Objective**
Obtain a detailed understanding of
- the development, activation, and differentiation of different types of T cells and their effectormechanisms during immune responses,
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter,
- events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells.
- Optimization of B cell responses by intelligent design of new vaccines

**Content**
o Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
o NK T cells and responses to lipid antigens
o Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
o Overview of cytokines and their effector function
o Co-stimulation (signals 1-3)
o Dendritic cells
o Evolution of the "Danger" concept
o Cells expressing Pattern Recognition Receptors and their downstream signals
o T cell function and dysfunction in acute and chronic viral infections

**Literature**
Documents of the lectures are available for download at: https://moodle-app2.let.ethz.ch/course/view.php?id=25811&notifyeditingon=1

**Prerequisites / notice**
Immunology I and II recommended but not compulsory

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**551-0512-00L**  Current Topics in Molecular and Cellular Neurobiology  W  2 credits  1S  U. Suter

**Number of participants limited to 8.**

**Abstract**
The course is a literature seminar or "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.

**Objective**
The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

**Content**
You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance. You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).

**Lecture notes**
Presentations will be made available after the seminars.

**Prerequisites / notice**
You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

**List of topics:**
- Eating sugars and letting them in (Ligno-)Cellulose and in demand for bioenergy
- Complex: (Ligno-)Cellulose and in demand for bioenergy
- Of climate relevance: The microbial C1 cycle
- What are AMO and Anammox?
- 20 amino acids: the making of the genetic code
- The 21st and 22nd amino acid
- Some exotic biochemistry: nucleotides, cofactors
- Ancient biochemistry? Iron-sulfur clusters, polymers
- Secondary metabolites: play/ground of evolution

**Abstract**
- The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms.

**Objective**
- Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

**Content**
- Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.
- Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycosylation, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.
- Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease

**Lecture notes**
- A script will be provided during the course.

**Literature**
- Introduction to Glycobiology; M.E.Taylor, K.Drickamer, Oxford University Press, 2003

**Prerequisites / notice**
- The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. The aim of the course is to confront students with current research topics and with scientific presentation. The course offers the opportunity to gain in depth knowledge about diverse topics which are often only briefly touched in the concept courses and to engage in discussion with experts in the field.
- The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

**Course description**

**551-1105-00L Glycobiology**
- **W 4 credits 2V**
- **M. Aebi, T. Henretta**
- **Objective**
- Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycosylation, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.
- **Content**
- Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease
- **Lecture notes**
- A script will be provided during the course.
- **Literature**
- Introduction to Glycobiology; M.E.Taylor, K.Drickamer, Oxford University Press, 2003
- **Prerequisites / notice**
- The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. The aim of the course is to confront students with current research topics and with scientific presentation. The course offers the opportunity to gain in depth knowledge about diverse topics which are often only briefly touched in the concept courses and to engage in discussion with experts in the field.
- The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

**551-1117-00L Cutting Edge Topics: Immunology and Infection Biology**
- **W 2 credits 1S**
- **A. Oxenius, B. Becher, C. Halin Winter, M. Kopf, S. R. Leibundgut, C. Münnz, A. Trkola, M. van den Broek**
- **Objective**
- The specific topics are variable and depend each semester on the list of invited experts.
- **Content**
- Immunology and infection biology.
- **Lecture notes**
- Script and original publications will be supplied during the course.
- **Prerequisites / notice**
- The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

**551-1153-00L Systems Biology of Metabolism**
- **W 4 credits 2V**
- **U. Sauer, N. Zamboni, M. Zampieri**
- **Number of participants limited to 15.**
- **Abstract**
- Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.
- **Objective**
- The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.
- **Content**
- Immunology and infection biology.
- **Lecture notes**
- Script and original publications will be supplied during the course.
- **Prerequisites / notice**
- The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

**551-1171-00L Immunology: from Milestones to Current Topics**
- **W 4 credits 2S**
- **B. Ludewig, J. Kisielow, M. Kopf, A. Oxenius, University lecturers**
- **Abstract**
- Milestones in Immunology: on old concepts and modern experiments
- **Objective**
- The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.
- **Content**
- Milestones and current topics of innate immunity, antigen presentation, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunity.
- **Lecture notes**
- Original and review articles will be distributed by the lecturer.
- **Literature**
- Literaturunterlagen werden vor Beginn des Kurses auf folgender website zugänglich sein: Moodle Course https://moodle-app2.let.ethz.ch/course/view.php?id=1002

**551-1303-00L Cellular Biochemistry of Health and Disease**
- **W 4 credits 2S**
- **P. Picotti, Y. Barral, V. Korkhov, B. Kornmann, R. Kroschewski, J. Matos, M. Peter, A. E. Smith, K. Weis**
- **Number of participants limited to 15.**
- **Abstract**
- Milestones in Immunology: on old concepts and modern experiments
- **Objective**
- The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.
- **Content**
- Milestones and current topics of innate immunity, antigen presentation, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunity.
- **Lecture notes**
- Original and review articles will be distributed by the lecturer.
- **Literature**
- Literaturunterlagen werden vor Beginn des Kurses auf folgender website zugänglich sein: Moodle Course https://moodle-app2.let.ethz.ch/course/view.php?id=1002
Separations in Biotechnology and Bioprocess

Objective
Students will work with experts toward a critical analysis of cutting-edge research in the domain of cellular biochemistry, with emphasis on normal cellular processes and the consequences of their dysregulation. At the end of the course, students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.

Content
Guided by an expert in the field, students will engage in classical round-table style discussions of current literature with occasional frontal presentations. Students will alternate as discussion leaders throughout the semester, with the student leader responsible to briefly summarize key general knowledge and context of the assigned primary research paper. Together with the faculty expert, all students will participate in discussion of the primary paper, including the foundation of the biological question, specific questions addressed, key methods, key results, remaining gaps and research implications.

Literature
The literature will be provided during the course

Prerequisites / notice
The course will be taught in English.

636-0001-00L
Separations in Biotechnology and Bioprocess

Economy
W 6 credits 3G S. Panke

Objective
Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select & roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations & judge on process economy.

Content
Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.

Lecture notes
Introduction membrane operations adsorption and chromatography crystallization overall process economics Handouts during course

752-4009-00L
Molecular Biology of Foodborne Pathogens

Abstract
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

Content
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and under factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

Lecture notes
Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

Literature
Recommendations will be given in the first lecture

Prerequisites / notice
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!

752-5103-00L
Functional Microorganisms in Foods

Abstract
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

Objective
To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

Content
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Special classes from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Prebiotics

Students will be required to complete a group project on food products and ingredients with or from functional bacteria. The Project will involve information research and analysis followed by an oral presentation and short written report.

Lecture notes
Copy of the power point slides from lectures will be provided.

Literature
A list of references will be given at the beginning of the course for the different topics presented during this course.

751-4504-00L
Plant Pathology I

Abstract
Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. 

Objective
Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems as a basis for implementing disease management strategies in agroecosystems.
Course description: Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

Lecture Topics and Tentative Schedule

Week 1  No Lecture: First day of autumn semester

Week 2  The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nematode attack strategies and types of damage.


Week 5  Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.

Week 6  Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, performed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytalexins and disease resistance.

Week 7  Pisatin and pisatin demethylase. Local and systemic acquired resistance, signal molecules.

Week 8  Pathogen effects on food quality and safety.

Week 9  Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics, including resistance, physiology, density, uniformity.

Week 10  Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.

Week 11  Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.

Week 12  Strategies for minimizing disease risks: principles of disease control and management.

Week 13  Disease control strategies: economic thresholds, physical control methods.

Week 14  Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

Lecture notes

Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.

551-1145-00L  Viral and non-Viral Vectors for Human Gene-Therapy - W 2 credits 3V University lecturers

from Pathogens to Safe Medical Applications

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: BIO708

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

Basic aspects of virology, the viral mechanisms for transfer of genetic material into cells, different vector-systems and target cells, animal models, specific applications for inborn diseases of the immune system and of metabolism, adverse effects, and new developments of vector systems will be taught.

Objective


636-0017-00L  Computational Biology  W 4 credits 3G T. Stadler, C. Magnus

Abstract

The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.

Objective

Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:

* stochastic models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics

Attendees will apply these concepts to a number of applications yielding biological insight into:

* epidemiology
* pathogen evolution
* macroevolution of species

Content

The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.
Lecture notes

Slides of the lecture will be available online.
https://www.bsse.ethz.ch/cevo/education/cb-materials.html

Literature

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

Prerequisites / notice

Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

751-4805-00L Recent Advances in Biocommunication

Number of participants limited to 25

Abstract

Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods.

Objective

Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods. Students will engage in discussion and critical analyses of relevant papers and present their evaluations in a seminar setting.

Elective Concept Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>752-4005-00L Food Microbiology</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Loessner</td>
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Abstract

This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

Objective

The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms. The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.

Content

1. History of Food Microbiology
   1.1. Short synopsis of foodborne microorganisms
   1.2. Spoilage of Foods
   1.3. Foodborne Disease
   1.4. Food Preservation
   1.5. VIP's of Food Microbiology
2. Overview of Microorganisms in Foods
   2.1 Origin of foodborne Microorganisms
   2.2. Bacteria
   2.3. Yeasts
   2.4. Molds
3. Microbial Spoilage of Foods
   3.1. Intrinsic and Extrinsic Parameters
   3.2. Meats, Seafoods, Eggs
   3.3. Milk and Milk Products
   3.4. Vegetable and Fruit Products
   3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   3.6. Drinks and Canned Foods
4. Foodborne Disease
   4.1. Significance and Transmission of Foodborne pathogens
   4.2. Staphylococcus aureus
   4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4.4. Listeria monocytogenes
   4.5. Salmonella, Shigella, Escherichia coli
   4.6. Vibrio, Yersinia, Campylobacter
   4.7. Brucella, Mycobacterium
   4.8. Parasites
   4.9. Viruses and Bacteriophages
   4.10. Mycotoxins
   4.11. Bioactive Amines
   4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

Lecture notes

Electronic copies of the presentation slides (PDF) and additional material will be made available for download.

Literature

Recommendations will be given in the first lecture

551-1295-00L Introduction to Bioinformatics: Concepts and Applications

Abstract

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Bioinformatics I will cover the following topics:
- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

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<tr>
<td>701-2413-00L</td>
<td>Evolutionary Genetics</td>
<td>W 6</td>
<td>4V</td>
<td>T. Städler, A. Widmer</td>
</tr>
<tr>
<td>551-0307-00L</td>
<td>Molecular and Structural Biology I: Protein Structure and Function</td>
<td>W 3</td>
<td>2V</td>
<td>R. Glockshuber, K. Locher, E. Weber-Ban</td>
</tr>
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</table>

Abstract: The concept course 'Evolutionary Genetics' consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

Objective: The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods and explanatory power of evolutionary genetics.

Content: Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory.

Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding, effects on fitness; Fisher's fundamental theorem.

Ecological Genetics - Concepts and methods for the study of genetic variation and its role in adaptation, reproductive isolation, hybridization and speciation.

Lecture notes: Handouts


Prerequisites / notice: There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.
Abstract
Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

Objective
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

Lecture notes
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

Literature
Basics:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.

551-0309-00L Concepts in Modern Genetics W 6 credits 4V Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voinnet

Abstract
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective
This course focuses on the concepts of classical and modern genetics and genomics.

Content
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes
Scripts and additional material will be provided during the semester.

Prerequisites / notice
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hönggerberg, and on Tuesday morning at UZH Irchel.

551-0319-00L Cellular Biochemistry (Part I) W 3 credits 2V U. Kutay, R. I. Enchev, B. Kornmann, M. Peter, I. Zemp, further lecturers

Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Lecture notes
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

529-0731-00L Nucleic Acids and Carbohydrates W 6 credits 3G D. Hilvert, P. A. Kast, S. J. Sturla, H. Wennen

Abstract
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Objective
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Content
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Lecture notes
no script

Literature
Mainly based on recent original literature, a detailed list will be distributed during the first lecture

Elective Major: Cell Biology

Elective Compulsory Concept Courses
See D-BIOL Master Studies Guide

Number Title Type ECTS Hours Lecturers
551-0319-00L Cellular Biochemistry (Part I) W 3 credits 2V U. Kutay, R. I. Enchev, B. Kornmann, M. Peter, I. Zemp, further lecturers

Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.
Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

Content
The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Lecture notes
Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

Literature
- Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

Prerequisites / notice
Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

551-1295-00L
Introduction to Bioinformatics: Concepts and Applications

Objective
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.
Content  Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

376-1305-10L  Neurobiology  W  6 credits  4V  M. E. Schwab, E. Stoeckli, L. Filli, K. A. Martin, further lecturers

Abstract  Development of the nervous system (NS); the adult NS, plasticity and regeneration, sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, diseases of the NS.

Objective  Overview of normal development, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content  Development: Early development of the nervous system, cellular level, nerve fiber growth, building of neuronal networks; biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes  Structure, Plasticity and Repair of the Nervous System (376-1305-01L): Lecture notes will be provided on Moodle https://moodle- Bioinformatics I will cover the following topics:

- The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0512-00L</td>
<td>Current Topics in Molecular and Cellular Neurobiology</td>
<td>W</td>
<td>2 credits</td>
<td>1S</td>
<td>U. Suter</td>
</tr>
<tr>
<td>551-0571-00L</td>
<td>From DNA to Diversity (University of Zurich)</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>A. Hajnal, D. Bopp, E. Hafen</td>
</tr>
<tr>
<td>551-1103-00L</td>
<td>Microbial Biochemistry</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>J. Vorholt-Zambelli, J. Piel</td>
</tr>
</tbody>
</table>

Elective Compulsory Master Courses

Number  Title  Type  ECTS  Hours  Lecturers
551-0512-00L  Current Topics in Molecular and Cellular Neurobiology  W  2 credits  1S  U. Suter

Abstract  The course is a literature seminar or "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.

Objective  The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

Content  You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance.

Lecture notes  Number of participants limited to 8.

Prerequisites / notice  You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).

551-0571-00L  From DNA to Diversity (University of Zurich)  W  2 credits  2V  A. Hajnal, D. Bopp, E. Hafen

Abstract  No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BIO336

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Objective  The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

- By the end of this module, each student should be able to
- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.

Key skills:
- By the end of this module, each student should be able to
- present and discuss a relevant evolutionary topic in an oral presentation
- select and integrate key concepts in animal evolution from primary literature
- participate in discussions on topics presented by others

551-1103-00L  Microbial Biochemistry  W  4 credits  2V  J. Vorholt-Zambelli, J. Piel

Abstract  The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.

Objective  The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms.
Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

List of topics:
- Eating sugars and letting them in
- Challenging: Aromatics, xenobiotics, and oil
- Complex: (Ligno-)Cellulose and in demand for bioenergy
- Living on a diet and the anaerobicerotic provocation
- Of climate relevance: The microbial C1 cycle
- What are AMO and Anammox?
- 20 amino acids: the making of
- Extending the genetic code
- The 21st and 22nd amino acid
- Some exotic biochemistry: nucleotides, cofactors
- Ancient biochemistry? Iron-sulfur clusters, polymers
- Secondary metabolites: playground of evolution

A script will be provided during the course.

**551-1105-00L**
**Glycobiology**

<table>
<thead>
<tr>
<th>Content</th>
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</thead>
<tbody>
<tr>
<td>Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.</td>
</tr>
</tbody>
</table>

| Objective |
| Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycobiology, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease. |

**Abstract**

Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

**Literature**


**Prerequisites / notice**

- The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

**551-1117-00L**
**Cutting Edge Topics: Immunology and Infection Biology**

<table>
<thead>
<tr>
<th>Content</th>
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</thead>
<tbody>
<tr>
<td>Immunology and infection biology. The specific topics are variable and depend each semester on the list of invited experts.</td>
</tr>
</tbody>
</table>

**Objective**

Weekly seminar about cutting edge topics in immunology and infection biology. Internationally renowned experts present their current research followed by an open discussion.

**Abstract**

Weekly seminar about cutting edge topics in immunology and infection biology. Internationally renowned experts present their current research followed by an open discussion.

**Literature**

- Immunology: from Milestones to Current Topics, B. Becher, B. Ludewig, J. Kieselow, M. Kopf, A. Oxenius, University lecturers

**Prerequisites / notice**

- The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

**551-1303-00L**
**Cellular Biochemistry of Health and Disease**

<table>
<thead>
<tr>
<th>Content</th>
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<tbody>
<tr>
<td>During this Masters level seminar style course, students will explore current research topics in cellular biochemistry focused on the structure, function and regulation of selected cell components, and the consequences of dysregulation for pathologies.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Literature</th>
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</thead>
<tbody>
<tr>
<td>Literatureunterlagen werden vor Beginn des Kurses auf folgender website zugänglich sein: Moodle Course <a href="https://moodle-app2.leti.ethz.ch/course/view.php?id=1002">https://moodle-app2.leti.ethz.ch/course/view.php?id=1002</a></td>
</tr>
</tbody>
</table>

**Prerequisites / notice**

- The specific topics are variable and depend each semester on the list of invited experts.
Objective

Students will work with experts toward a critical analysis of cutting-edge research in the domain of cellular biochemistry, with emphasis on normal cellular processes and the consequences of their dysregulation. At the end of the course, students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.

Content

Guided by an expert in the field, students will engage in classical round-table style discussions of current literature with occasional frontal presentations. Students will alternate as discussion leaders throughout the semester, with the student leader responsible to briefly summarize key general knowledge and context of the assigned primary research paper. Together with the faculty expert, all students will participate in discussion of the primary paper, including the foundation of the biological question, specific questions addressed, key methods, key results, remaining gaps and research implications.

Literature

The literature will be provided during the course

Prerequisites / notice

The course will be taught in English

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**Elective Major: Molecular Health Sciences**

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**Elective Compulsory Master Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<td>551-0571-00L</td>
<td>From DNA to Diversity (University of Zurich)</td>
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<td>2V</td>
<td>A. Hajnal, D. Bopp, E. Hafen</td>
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</tbody>
</table>

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

Objective

By the end of this module, each student should be able to:
- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.

Key skills:
By the end of this module, each student should be able to:
- present and discuss a relevant evolutionary topic in an oral presentation
- select and integrate key concepts in animal evolution from primary literature
- participate in discussions on topics presented by others

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551-1303-00L | Cellular Biochemistry of Health and Disease | W | 4 credits | 2S | P. Picotti, Y. Barral, V. Korkhov, B. Kornmann, R. Kroschewski, J. Matos, M. Peter, A. E. Smith, K. Weis |

Abstract

During this Masters level seminar style course, students will explore current research topics in cellular biochemistry focused on the structure, function and regulation of selected cell components, and the consequences of dysregulation for pathologies.

Objective

Students will work with experts toward a critical analysis of cutting-edge research in the domain of cellular biochemistry, with emphasis on normal cellular processes and the consequences of their dysregulation. At the end of the course, students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.
Guided by an expert in the field, students will engage in classical round-table style discussions of current literature with occasional frontal presentations. Students will alternate as discussion leaders throughout the semester, with the student leader responsible to briefly summarize key general knowledge and context of the assigned primary research paper. Together with the faculty expert, all students will participate in discussion of the primary paper, including the foundation of the biological question, specific questions addressed, key methods, key results, remaining gaps and research implications.

The course will be taught in English.
The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.

The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.
Content

What is translational science and what is it not?

How to identify need?

- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
- How to measure success?
- Outcome variables
- Improving the translational process
- Challenges of communication?
- How independent is translational science?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

551-1145-00L Viral and non-Viral Vectors for Human Gene-Therapy - from Pathogens to Safe Medical Applications

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: BIO708

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

Basic aspects of virology, the viral mechanisms for transfer of genetic material into cells, different vector-systems and target cells, animal models, specific applications for inborn diseases of the immune system and of metabolism, adverse effects, and new developments of vector systems will be taught.

Objective

Knowledge of important viral and non-viral vector systems.

Knowledge of application in human diseases.

Knowledge of limiting factors.

551-1407-00L RNA Biology Lecture Series I: Transcription & Processing & Translation

This course covers aspects of RNA biology related to gene expression at the posttranscriptional level. These include RNA transcription, processing, alternative splicing, editing, export and translation.

Objective

The students should obtain an understanding of these processes, which are at work during gene expression.

Content

Transcription & 3’end formation ; splicing, alternative splicing, RNA editing; the ribosome & translation, translation regulation, RNP biogenesis & nuclear export, mRNP surveillance & mRNA turnover; signal transduction & RNA.

Prerequisites / notice

Basic knowledge of cell and molecular biology.

Elective Major: Biochemistry

Compulsory Concept Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>U. Kutay, R. I. Enchev, B. Kornmann, M. Peter, I. Zemp, further lecturers</td>
</tr>
</tbody>
</table>

Abstract

Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Lecture notes

Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature

Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

Compulsory Master Course

<table>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>551-1303-00L</td>
<td>Cellular Biochemistry of Health and Disease</td>
<td>O</td>
<td>4</td>
<td>2S</td>
<td>P. Picotti, Y. Barral, V. Korkhov, B. Kornmann, R. Kroschewski, J. Matos, M. Peter, A. E. Smith, K. Weis</td>
</tr>
</tbody>
</table>

Abstract

During this Masters level seminar style course, students will explore current research topics in cellular biochemistry focused on the structure, function and regulation of selected cell components, and the consequences of dysregulation for pathologies.

Objective

Students will work with experts toward a critical analysis of cutting-edge research in the domain of cellular biochemistry, with emphasis on normal cellular processes and the consequences of their dysregulation. At the end of the course, students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.
Content
Guided by an expert in the field, students will engage in classical round-table style discussions of current literature with occasional frontal presentations. Students will alternate as discussion leaders throughout the semester, with the student leader responsible to briefly summarize key general knowledge and context of the assigned primary research paper. Together with the faculty expert, all students will participate in discussion of the primary paper, including the foundation of the biological question, specific questions addressed, key methods, key results, remaining gaps and research implications.

Literature
The literature will be provided during the course

Prerequisites / notice
The course will be taught in English.

Elective Compulsory Concept Courses

See D-BIOL Master Studies Guide

<table>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>551-0307-00L</td>
<td>Molecular and Structural Biology I: Protein Structure and Function</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Glockshuber, K. Locher, E. Weber-Ban</td>
</tr>
<tr>
<td></td>
<td>(next semester) as a two-semester course</td>
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<tr>
<td>Abstract</td>
<td>Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Scripts on the individual topics can be found under <a href="http://www.mol.biol.ethz.ch/teaching">http://www.mol.biol.ethz.ch/teaching</a>.</td>
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</table>

| 551-0309-00L | Concepts in Modern Genetics | W    | 6    | 4V    | Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voinnet |
| Abstract     | Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference. |      |      |       |                      |
| Objective    | This course focuses on the concepts of classical and modern genetics and genomics. |      |      |       |                      |
| Content      | The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference. |      |      |       |                      |
| Lecture notes | Scripts and additional material will be provided during the semester. |      |      |       |                      |
| Literature   | This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel. |      |      |       |                      |

Elective Compulsory Master Courses

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<tbody>
<tr>
<td>529-0733-00L</td>
<td>Enzymes</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>D. Hilvert</td>
</tr>
<tr>
<td>Abstract</td>
<td>Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.</td>
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<tr>
<td>Objective</td>
<td>Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.</td>
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<td>Content</td>
<td>Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.</td>
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<tr>
<td>Lecture notes</td>
<td>A script will not be handed out.</td>
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| 551-1105-00L | Glycobiology    | W    | 4    | 2V    | M. Aebi, T. Henriet |
| Abstract     | Structure, principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed. |      |      |       |                      |
| Objective    | Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycobiology, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease. |      |      |       |                      |
| Content      | Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease |      |      |       |                      |
| Lecture notes | Handouts |      |      |       |                      |
| Prerequisites / notice | The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology. |      |      |       |                      |

| 551-1103-00L | Microbial Biochemistry | W    | 4    | 2V    | J. Vorholt-Zambelli, J. Piel |
| Abstract     | The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. |      |      |       |                      |
| Objective    | The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. |      |      |       |                      |
Content

Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

List of topics:
- Eating sugars and letting them in
- Challenging: Aromatics, xenobiotics, and oil
- Complex: (Ligro-)Cellulose and in demand for biocenergy
- Living on a diet and the anaerolitic provocuation
- Of climate relevance: The microbial C1 cycle
- What are AMO and Anamox?
- 20 amino acids: the making of
- Extending the genetic code
- The 21st and 22nd amino acid
- Some exotic biochemistry: nucleotides, cofactors
- Ancient biochemistry? iron-sulfur clusters, polymers
- Secondary metabolites: playground of evolution

Lecture notes

A script will be provided during the course.

551-1153-00L Systems Biology of Metabolism

W 4 credits 2V U. Sauser, N. Zamboni, M. Zampieri

Abstract

Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

Objective

Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content

The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics.

For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metaboimics and other omics.

Lecture notes

Script and original publications will be supplied during the course.

Prerequisites / notice

The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

636-0001-00L Separations in Biotechnology and Bioprocess Economy

W 6 credits 3G S. Panke

Abstract

Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select & roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations & judge on process economy.

Objective

Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.

Content

Introduction to membrane operations, adsorption and chromatography, crystallization, overall process economics

Lecture notes

Handouts during course

636-0007-00L Computational Systems Biology

W 6 credits 3V+2U J. Stelling

Abstract

Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective

The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content

Biologist has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label “Systems Biology”, focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Lecture notes

https://www.ethz.ch/content/specialinterest/bsse/computational-systems-biology/en/education/lectures/csb/LectureMaterial.html

Literature


401-0649-00L Applied Statistical Regression

W 5 credits 2V+1U M. Dettling

Abstract

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

Objective

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content

The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

Lecture notes

A script will be available.

Literature

Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis
### Elective Concept Courses

#### Number
- **551-0307-00L**
  - **Molecular and Structural Biology I: Protein Structure and Function**
  - **Type**: W
  - **ECTS**: 3
  - **Hours**: 2V
  - **Lecturers**: R. Glockshuber, K. Locher, E. Weber-Ban

#### Abstract
- Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

#### Objective
- The students should gain an understanding of the mechanisms underlying these processes, as well as modern methods for protein purification and microanalysis.

#### Literature
- Creighton, T. E., Proteins, Freeman (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman

#### Excerpt from Current References:
- Current references will be given during the lectures.

#### Number
- **551-0309-00L**
  - **Concepts in Modern Genetics**
  - **Type**: W
  - **ECTS**: 6
  - **Hours**: 4V
  - **Lecturers**: Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voinnet

#### Abstract
- Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

#### Objective
- This course focuses on the concepts of classical and modern genetics and genomics.

#### Content
- The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

#### Lecture notes
- Scripts and additional material will be provided during the semester.
### 551-0313-00L Microbiology (Part I)

- **W** 3 credits 2V  
  W.D. Hardt, L. Ebert, H.M. Fischer, J. Piel, M. Pilhofer

#### Prerequisites / notice
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel.

#### Abstract
Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

#### Objective
This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

#### Content
Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

#### Lecture notes
Updated handouts will be provided during the class.

#### Literature
Current literature references will be provided during the lectures.

#### Prerequisites / notice
English

The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

### 551-0317-00L Immunology I

- **W** 3 credits 2V  
  A. Oxenius, M. Kopf

#### Prerequisites / notice
Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

#### Abstract
Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

#### Objective
Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

#### Content
- Introduction and historical background
- Intra- and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histocompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

#### Lecture notes
Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

#### Literature

### 551-1295-00L Introduction to Bioinformatics: Concepts and Applications

- **W** 6 credits 4G  
  W. Grussem, K. Bärenfaller, A. Callisch, G. Capitani, J. Fütterer, M. Robinson, A. Wagner

#### Prerequisites / notice
In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

#### Content
Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

### 529-0731-00L Nucleic Acids and Carbohydrates

- **W** 6 credits 3G  
  D. Hilvert, P. A. Kast, S. J. Sturla, H. Wennemers

#### Prerequisites / notice
No script

#### Abstract
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

#### Objective
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

#### Content
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccine

#### Literature
Mainly based on recent original literature, a detailed list will be distributed during the first lecture.
The advanced course introduces students to plants through a concept-based discussion of developmental processes that integrates physiology and biochemistry with genetics, molecular biology, and cell biology. The course follows the life of the plant, starting with the seed, progressing through germination to the seedling and mature plant, and ending with reproduction and senescence.

The new course "Molecular Life of Plants" reflects the rapid advances that are occurring in the field of experimental plant biology as well as the changing interests of students being trained in this discipline. Contemporary plant biology courses emphasize a traditional approach to experimental plant biology by discussing discrete topics that are removed from the context of the plant life cycle. The course will take an integrative approach that focuses on developmental concepts. Whereas traditional plant physiology courses were based on research carried out on intact plants or plant organs and were often based on phenomenological observations, current research in plant biology emphasizes work at the cellular, subcellular and molecular levels.

The goal of "Molecular Life of Plants" is to train students in integrative approaches to understand the function of plants in a developmental context. While the course focuses on plants, the training integrative approaches will also be useful for other organisms.

The course "Molecular Life of Plants" will cover the following topics in a developmental context:

- Plant genome organization
- Seed anatomy
- Food reserves and mobilization
- Seedling emergence
- Heterotrophic to autotrophic growth
- Chlorophyll biosynthesis, photoreceptors
- Integration of metabolism
- Hormones
- Cell cycle
- Cell differentiation and expansion
- Environmental interactions: abiotic
- Environmental interactions: biotic
- Flower development and fertilization
- Embryo and seed development
- Fruit development
- Senescence

**Elective Compulsory Concept Courses**

*See D-BIOL Master Studies Guide*

<table>
<thead>
<tr>
<th>Number</th>
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<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>R. Glockshuber, K. Locher, E. Weber-Ban</td>
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<td>D-BIOL BSc students are obliged to take part I and part II (next semester) as a two-semester course</td>
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<tr>
<td>551-0309-00L</td>
<td>Concepts in Modern Genetics</td>
<td>W</td>
<td>6 credits</td>
<td>4V</td>
<td>Y. Barrat, D. Bopp, A. Hajnal, M. Stoffel, O. Voinnet</td>
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<tr>
<td>551-0313-00L</td>
<td>Microbiology (Part I)</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pilhofer</td>
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**Elective Major: Plant Biology**

The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

**Autumn Semester 2016**
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background, structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Storage and handling of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

The concept course 'Evolutionary Genetics' consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods and explanatory power of evolutionary genetics.

Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory.

Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding; effects on fitness; Fisher's fundamental theorem.

Ecological Genetics - Concepts and methods for the study of genetic variation and its role in adaptation, reproductive isolation, hybridization and speciation.

The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

System-Oriented Management of Herbivore Insects I

The course focuses on the management of herbivore insects in agricultural, ecological, and industrial contexts. Students will learn to analyze and manage insect populations using quantitative models and understanding the complex interactions between insects and their environment.

There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.
Abstract
The focus is on the potential to assess strategies and tactics of pest management, taking into account the demands from the economy, the environment and the society. Significant agricultural approaches will be explained using practical examples, including prevention using natural resources, surveillance and forecasting, resistance management, as well as product registration, incl. ecotoxicology.

Objective
The students gain a good understanding of fundamental aspects of pest management in agroecosystems. They will have the ability to assess options for action in view of requirements from the economy, the ecology and the society. Further, they will learn to perform searches on relevant issues in pest management, and to critically evaluate case studies.

551-1105-00L
Glycobiology

Abstract
Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

Objective
Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycosylation, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.

Content
Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminylglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease

Lecture notes
handouts

Literature
Introduction to Glycobiology; M.E. Taylor, K. Drickamer, Oxford University Press, 2003

Prerequisites / notice
The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

551-1103-00L
Microbial Biochemistry

Abstract
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.

Objective
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms.

Content
Importantly, biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

List of topics:
Eating sugars and letting them in
Challenging: Aromatics, xenobiotics, and oil
Complex: (Ligno-)Cellulose and in demand for bioenergy
Living on a diet and the anaerobic provocation
Of climate relevance: The microbial C1 cycle
What are AMO and Anamox?
20 amino acids: the making of
Extending the genetic code
The 21st and 22nd amino acid
Some exotic biochemistry: nucleotides, cofactors
Ancient biochemistry? Iron-sulfur clusters, polymers
Secondary metabolites: playground of evolution

Lecture notes
A script will be provided during the course.

529-0733-00L
Enzymes

Abstract
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Objective
Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

Content
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Lecture notes
A script will not be handed out.

Literature
General:

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

751-5121-00L
Insect Ecology

Abstract
This is an introductory course in insect ecology. Students will learn about the ways in which insects interact with and adapt to their abiotic and biotic environments and their roles in diverse ecosystems. The course will entail lectures, outside readings, and critical analysis of contemporary literature.

Objective
Students completing this course should become familiar with the application of ecological principles to the study of insects, as well as major areas of inquiry in this field. Highlighted topics will include insect behavior, chemical and sensory ecology, physiological responses to biotic and abiotic stressors, plant-insect interactions, community and food-web dynamics, and disease ecology. The course will emphasize insect evolution and adaptation in the context of specific interactions with other organisms and the abiotic environment. Examples from the literature incorporated into lectures will highlight the methods used to study insect ecology.

Lecture notes
Provided to students through ILIAS

Literature
Selected required readings (peer reviewed literature, selected book chapters). Optional recommended readings with additional information.

551-1153-00L
Systems Biology of Metabolism

Abstract
Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

Objective
Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content
The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes
Script and original publications will be supplied during the course.
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

### Prerequisites / notice
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

#### 751-4504-00L
**Plant Pathology**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<td>551-0307-00L</td>
<td>Molecular and Structural Biology I: Protein Structure and Function</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>R. Glockshuber, K. Locher, E. Weber-Ban</td>
</tr>
</tbody>
</table>

**Abstract**

This course covers aspects of RNA biology related to gene expression at the posttranscriptional level. These include RNA transcription, processing, alternative splicing, editing, export and translation.

**Objective**

The students should obtain an understanding of these processes, which are at work during gene expression. Transcription & 3’end formation; splicing, alternative splicing, RNA editing; the ribosome & translation, translation regulation, RNP biogenesis & nuclear export, mRNA surveillance & miRNA turnover; signal transduction & RNA. Students will engage in discussion and critical analyses of relevant papers and present their evaluations in a seminar setting.

**Content**

This course will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

**Lecture Topics and Tentative Schedule**

**Week 1**
No Lecture: First day of autumn semester

**Week 2**
The nature of plant diseases, symbiosis, parasitism, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nematode attack strategies and types of damage.

**Week 3**

**Week 4**

**Week 5**
Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.

**Week 6**
Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, preformed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.

**Week 7**
Pisatin and pisatin demethylase. Local and systemic acquired resistance, signal molecules.

**Week 8**
Pathogen effects on food quality and safety.

**Week 9**
Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics,including resistance, physiology, density, uniformity.

**Week 10**
Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.

**Week 11**
Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.

**Week 12**
Strategies for minimizing disease risks: principles of disease control and management.

**Week 13**
Disease control strategies: economic thresholds, physical control methods.

**Week 14**
Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation. Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalysis.

Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

This course focuses on the concepts of classical and modern genetics and genomics.

The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hönggerberg, and on Tuesday morning at UZH Irchel.

Objectives

- To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology.
- The course will be taught in English.

Abstract

- Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Course content

- This course focuses on the concepts of classical and modern genetics and genomics.
- The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Current topics: References will be given during the lectures.

Lecture notes

- Scripts and additional material will be provided during the semester.
- Current literature references will be provided during the lectures.

Prerequisites / notice

- English
- The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

Prerequisites

- To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology.
- The course will be taught in English.

Current topics: References will be given during the lectures.

Lecture notes

- Scripts and additional material will be provided during the semester.
- Current literature references will be provided during the lectures.

Prerequisites / notice

- English
- The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

Prerequisites

- To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology.
- The course will be taught in English.

Introduction to Bioinformatics: Concepts and Applications

- Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Objective

- Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

The students will be able to describe the spatial and temporal regulation of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathways such as cancer.

Cellular and protein interaction networks
Protein structure prediction
Proteomics and de novo protein sequencing
Protein sequence comparisons
Protein expression analysis using microarrays
Gene expression analysis using microarrays
DNA structure prediction
Protein sequence comparisons
Proteomics and de novo protein sequencing
Protein structure prediction
Cellular and protein interaction networks
Molecular dynamics simulation

### Elective Major: Systems Biology

#### Elective Compulsory Concept Courses

**See D-BIOL Master Studies Guide**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>U. Kutay, R. I. Enchev, B. Kommann, M. Peter, I. Zemp, further lecturers</td>
</tr>
</tbody>
</table>

#### Abstract

Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

#### Objective

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular processes such as cancer.

#### Content

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

#### Lecture notes

Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

#### Literature

Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

#### Prerequisites / notice

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

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<tbody>
<tr>
<td>551-0309-00L</td>
<td>Concepts in Modern Genetics</td>
<td>W</td>
<td>6 credits</td>
<td>4V</td>
<td>Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voinnet</td>
</tr>
</tbody>
</table>

#### Abstract

Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

#### Objective

This course focuses on the concepts of classical and modern genetics and genomics.

#### Content

The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

#### Lecture notes

Scripts and additional material will be provided during the semester.

#### Literature

This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel.

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<tbody>
<tr>
<td>551-0313-00L</td>
<td>Microbiology (Part I)</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pihlhofer</td>
</tr>
</tbody>
</table>

#### Abstract

Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

#### Content

Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

#### Lecture notes

Updated handouts will be provided during the class.

#### Literature

Current literature references will be provided during the lectures.

#### Prerequisites / notice

English

The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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</thead>
</table>

#### Abstract

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

Elective Compulsory Master Courses I: Computation

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>636-0007-00L</td>
<td>Computational Systems Biology</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>J. Stelling</td>
</tr>
<tr>
<td>Abstract</td>
<td>Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).</td>
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<tr>
<td>Objective</td>
<td>The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.</td>
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<tr>
<td>Content</td>
<td>Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label &quot;Systems Biology&quot;, focuses on networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks. We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.</td>
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<tr>
<td>636-0706-00L</td>
<td>Spatio-Temporal Modelling in Biology</td>
<td>W</td>
<td>5</td>
<td>3G</td>
<td>D. Iber</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course focuses on modeling spatio-temporal problems in biology, in particular on the cell and tissue level. A wide range of mathematical techniques will be presented as part of the course, including concepts from non-linear dynamics (ODE and PDE models), stochastic techniques (SDE, Master equations, Monte Carlo simulations), and thermodynamic descriptions.</td>
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<tr>
<td>Objective</td>
<td>The aim of the course is to introduce students to state-of-the-art mathematical modelling of spatio-temporal problems in biology. Students will learn how to choose from a wide range of modelling techniques and how to apply these to further our understanding of biological mechanisms. The course aims at equipping students with the tools and concepts to conduct successful research in this area; both classical as well as recent research work will be discussed.</td>
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<tr>
<td>Content</td>
<td>1. Introduction to Modelling in Biology</td>
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<tr>
<td>Lecture notes</td>
<td>All lecture material will be made available online <a href="https://www.bsse.ethz.ch/cobi/education/636-0706-00L_Spatial_Modelling_in_Biology.html">https://www.bsse.ethz.ch/cobi/education/636-0706-00L_Spatial_Modelling_in_Biology.html</a></td>
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</table>
Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key

**Elective Compulsory Master Courses II: Biology**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-1103-00L</td>
<td>Microbial Biochemistry</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>J. Vorholt-Zambelli, J. Piel</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.</td>
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<tr>
<td>Objective</td>
<td>The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms.</td>
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<tr>
<td>Content</td>
<td>Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.</td>
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</tbody>
</table>
| Literature     | Murray, Mathematical Biology, Springer  
Forgacs and Newman, Biological Physics of the Developing Embryo, CUP  
Keener and Seyd, Mathematical Physiology, Springer  
Fall et al, Computational Cell Biology, Springer  
Szalasi et al, System Modeling in Cellular Biology, MIT Press  
Wolkenhauer, Systems Biology  
Kreyszig, Engineering Mathematics, Wiley |

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</thead>
<tbody>
<tr>
<td>551-1153-00L</td>
<td>Systems Biology of Metabolism</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>U. Sauer, N. Zamboni, M. Zampieri</td>
</tr>
<tr>
<td>Abstract</td>
<td>Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.</td>
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<tr>
<td>Objective</td>
<td>Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.</td>
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<tr>
<td>Content</td>
<td>The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.</td>
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<tr>
<td>Lecture notes</td>
<td>A script will be provided during the course.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.</td>
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<tbody>
<tr>
<td>636-0001-00L</td>
<td>Separations in Biotechnology and Bioprocess Economy</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>S. Panke</td>
</tr>
<tr>
<td>Abstract</td>
<td>Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select &amp; roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations &amp; judge on process economy.</td>
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<tr>
<td>Objective</td>
<td>Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.</td>
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<tr>
<td>Content</td>
<td>Introduction membrane operations adsorption and chromatography crystallization overall process economics</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts during course</td>
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<tr>
<td>636-0507-00L</td>
<td>Synthetic Biology II</td>
<td>W</td>
<td>4</td>
<td>4A</td>
<td>S. Panke, Y. Benenson, J. Stelling</td>
</tr>
<tr>
<td>Abstract</td>
<td>7 months biological design project, during which the students are required to give presentations on advanced topics in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).</td>
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<tr>
<td>Objective</td>
<td>The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.</td>
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<tr>
<td>Content</td>
<td>Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external,) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (<a href="http://www.igem.org">www.igem.org</a>).</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts during course</td>
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<tbody>
<tr>
<td>551-0571-00L</td>
<td>From DNA to Diversity (University of Zurich)</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>A. Hajnal, D. Bopp, E. Hafen</td>
</tr>
<tr>
<td>Abstract</td>
<td>The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc. This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April. Please note that the number of ECTS credits and the actual work load are disconnected.</td>
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</table>
| Literature      | Notice: 20 amino acids: the making of  
What are AMO and Anammox?  
20 amino acids: the making of  
Living on a diet and the anaplerotic provocation  
Of climate relevance: The microbial C1 cycle  
Ancient biochemistry? nucleotides, cofactors  
The 21st and 22nd amino acid  
Secondary metabolites: playground of evolution  

data: 06.11.2018 12:57 Autumn Semester 2016 Page 274 of 1571
By the end of this module, each student should be able to:
- recognize the universal principles underlying the development of different animal body plans,
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity,
- relate changes in gene structure or function to evolutionary changes in animal development.

Key skills:
- By the end of this module, each student should be able to:
  - present and discuss a relevant evolutionary topic in an oral presentation
  - select and integrate key concepts in animal evolution from primary literature
  - participate in discussions on topics presented by others

636-0009-00L Evolutionary Dynamics W 5 credits 2V+1U N. Beerenwinkel

- Evolutionary dynamics is concerned with the mathematical principles according to which life has evolved. This course offers an introduction to mathematical modeling of evolution, including deterministic and stochastic models.
- The goal of this course is to understand and to appreciate mathematical models and computational methods that provide insight into the evolutionary process.


636-0009-00L Evolutionary Dynamics W 5 credits 2V+1U N. Beerenwinkel

- Evolutionary dynamics is concerned with the mathematical principles according to which life has evolved. This course offers an introduction to mathematical modeling of evolution, including deterministic and stochastic models.
- The goal of this course is to understand and to appreciate mathematical models and computational methods that provide insight into the evolutionary process.


Elective Major: Structural Biology and Biophysics

Elective Compulsory Concept Courses

See D-BIOL Master Studies Guide

Number Title Type ECTS Hours Lecturers
551-0307-00L Molecular and Structural Biology I: Protein Structure and Function O 3 credits 2V R. Glockshuber, K. Locher, E. Weber-Ban

D-BIOL BSc students are obliged to take part I and part II (next semester) as a two-semester course

Abstract Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

Objective Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytis.

Lecture notes Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

Literature Basics:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.

Cellular Biochemistry (Part I) W 3 credits 2V U. Kutay, R. I. Enchev, B. Kornmann, M. Peter, I. Zemp, further lecturers

Number Title Type ECTS Hours Lecturers
551-0319-00L Cellular Biochemistry (Part I) W 3 credits 2V U. Kutay, R. I. Enchev, B. Kornmann, M. Peter, I. Zemp, further lecturers

Abstract Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.
### 529-0731-00L

#### Nucleic Acids and Carbohydrates

**W 6 credits 3G**

**D. Hilvert, P. A. Kast, S. J. Sturfel, H. Wennemers**

**Abstract**
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Objective**
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Content**
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Lecture notes**
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biolog.ethz.ch)

**Literature**
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

**Prerequisites / notice**
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

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### 551-0313-00L

#### Introduction to Bioinformatics I: Concepts and Applications

**W 3 credits 2V**

**W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pilhofer**

**Abstract**
This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis. It will also provide an overview of recent developments and trends in the field of bioinformatics and computational biology.

**Objective**
Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Lecture notes**
Updated handouts will be provided during the class.

**Literature**
Current literature references will be provided during the lectures.

**Prerequisites / notice**
English

The lecture “Grundlagen der Biologie II: Mikrobiologie” is the basis for this advanced lecture.

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### 551-1295-00L

#### Introduction to Bioinformatics: Concepts and Applications

**W 6 credits 4G**

**W. Gruissem, K. Bärentnäßer, A. Calissi, G. Capitani, J. Fütterer, M. Robinson, A. Wagner**

**Abstract**
Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

**Objective**
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

**Content**
Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

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### 551-0309-00L

#### Concepts in Modern Genetics

**W 6 credits 4V**

**Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voïnnet**

**Abstract**
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Objective**
This course focuses on the concepts of classical and modern genetics and genomics.

**Content**
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Lecture notes**
Scripts and additional material will be provided during the semester.

**Prerequisites / notice**
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hönggerberg, and on Tuesday morning at UZH Irchel.

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### Elective Compulsory Master Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>529-0733-00L</td>
<td>Enzymes</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>D. Hilvert</td>
</tr>
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</table>

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Data: 06.11.2018 12:57  Autumn Semester 2016  Page 276 of 1571
Abstract
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Objective
Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

Content
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Lecture notes
A script will not be handed out.

Literature
General:

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

551-1105-00L Glycobiology W 4 credits 2V M. Aebi, T. Henriet
Abstract
Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

Objective
Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycobiology, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.

Content
Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease

Lecture notes
Handouts

Literature
Introduction to Glycobiology; M.E. Taylor, K. Drickamer, Oxford University Press, 2003

Prerequisites / notice
The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

551-1103-00L Microbial Biochemistry W 4 credits 2V J. Vorholt-Zambelli, J. Piel
Abstract
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.

Objective
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms.

Content
Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

List of topics:
- Eating sugars and letting them in
- Challenging: Aromatics, xenobiotics, and oil
- Complex: (Ligno-)Cellulose and in demand for bioenergy
- Extending the genetic code
- Some exotic biochemistry: nucleotides, cofactors
- Secondary metabolites: playground of evolution

Lecture notes
A script will be handed out during the course.

551-1401-00L Advanced Protein Engineering (University of Zurich) W 2 credits 2G A. Plückthun
Abstract
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BCH420

Restricted to max. 10 students from ETH

Objective
Introduction into current research strategies in protein science.

Content
Proteins have become an object of intense study in modern science, ranging from their use as therapeutics to elucidating their structure and function in the cell. Moreover, it is now possible to engineer and evolve tailor-made proteins, opening up many new areas of science. This course will attempt to cover the frontiers and remaining challenges, emphasizing the biochemical foundations of the various approaches.

Lecture notes
Slides and references will be available on OLAT server.

Literature
https://www.olat.uzh.ch/olat/auth/repo/go?rid=600670219

Prerequisites / notice
Solid knowledge in biochemistry strongly recommended.

551-1153-00L Systems Biology of Metabolism W 4 credits 2V U. Sauer, N. Zamboni, M. Zampieri
Abstract
Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach methods and concepts.

Objective
Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content
The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics.

For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes
Script and original publications will be supplied during the course.
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

**529-0004-00L Computer Simulation in Chemistry, Biology and Physics**

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>7 credits</th>
<th>4G</th>
<th>P. H. Hünenberger</th>
</tr>
</thead>
</table>

**Abstract**

Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

For more information: www.csms.ethz.ch/education/CSCBP

**Objective**

Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

**Content**

Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

**Lecture notes**

Available (copies of powerpoint slides distributed before each lecture)

**Literature**

See: www.csms.ethz.ch/education/CSCBP

**Prerequisites / notice**

Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/CSCBP

**401-0649-00L Applied Statistical Regression**

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>5 credits</th>
<th>2V+1U</th>
<th>M. Dettling</th>
</tr>
</thead>
</table>

**Abstract**

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

**Objective**

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

**Content**

The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

**Lecture notes**

A script will be available.

**Literature**

Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

**Prerequisites / notice**

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

**401-6215-00L Using R for Data Analysis and Graphics (Part I)**

<table>
<thead>
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<th>Prerequisites / notice</th>
<th>1 credit</th>
<th>1G</th>
<th>A. Drewek, A. J. Papritz</th>
</tr>
</thead>
</table>

**Abstract**

The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

**Objective**

The students will be able to use the software R for simple data analysis.

**Content**

The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part I of the course covers the following topics:

- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

**Lecture notes**

An Introduction to R. http://stat.ethz.ch/R/R contrib/Lam-IntroductionToR_LHL.pdf

The course resources will be provided via the Moodle web learning platform. Please login (with your ETH (or other University) username-password) at: https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145

Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

**529-0041-00L Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics**

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>6 credits</th>
<th>3G</th>
<th>R. Zenobi, M. Badertscher, B. Hattendorf, P. Martinez-Lozano Sinues</th>
</tr>
</thead>
</table>

**Abstract**

Modern mass spectrometry, hyphenated analytical methods, speciation. methods of surface analysis, chemometrics.

Comprehensive knowledge about the analytical methods introduced in this course, and their applications. Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation. Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods. Methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods). Employment of computer science for processing data in chemical analysis (chemometrics).
Lecture notes

lecture notes will be available in the lecture at production cost.

Literature

information about relevant literature will be available in the lecture & in the lecture notes.

Prerequisites / notice

Exercises are an integral part of the lecture.

Prerequisites:

529-0051-00 “Analytische Chemie I (3. Semester)”
529-0058-00 “Analytische Chemie II (4. Semester)” (or equivalent)

551-1411-00L Molecular and Structural Biology III: Current Topics

The course will only take place with a minimum of 6 participants.

Abstract

The course discusses current topics and cutting edge research in the structural, molecular, and biochemical study of cellular macromolecules. Student participation is an essential component of the course and will contribute to the exam grade.

Objective

The goal is to discuss cutting edge research in the structural, molecular, and biochemical study of cellular macromolecules. Students will also have an opportunity to present and discuss recent breakthroughs relevant to the research fields presented by the faculty teaching the course (see http://www.mol.biol.ethz.ch/research.html for details on the topics).

Literature

Will be distributed by the instructors.

551-1407-00L RNA Biology Lecture Series I: Transcription & Processing & Translation

W 4 credits 2V

F. Allain, N. Ban, U. Kutay, further lecturers

Abstract

This course covers aspects of RNA biology related to gene expression at the posttranscriptional level. These include RNA transcription, processing, alternative splicing, editing, export and translation.

Objective

The students should obtain an understanding of these processes, which are at work during gene expression.

Content

Transcription & 3’end formation ; splicing, alternative splicing, RNA editing; the ribosome & translation, translation regulation, RNP biogenesis & nuclear export, mRNA surveillance & mRNA turnover; signal transduction & RNA.

Prerequisites / notice

Basic knowledge of cell and molecular biology.

Elective Major: Biological Chemistry

Compulsory Concept Courses

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>529-0731-00L</td>
<td>Nucleic Acids and Carbohydrates</td>
<td>O</td>
<td>6</td>
<td>3G</td>
<td>D. Hilvert, P. A. Kast, S. J. Sturla, H. Wennemers</td>
</tr>
</tbody>
</table>

Abstract

Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines.

Objective

Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines.

Content

Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines.

Lecture notes

no script

Literature

Mainly based on recent original literature, a detailed list will be distributed during the first lecture.

Elective Compulsory Master Courses

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<td>636-0003-00L</td>
<td>Biological Engineering and Biotechnology</td>
<td>W</td>
<td>6</td>
<td>3V</td>
<td>M. Fussenegger</td>
</tr>
</tbody>
</table>

Abstract

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Objective

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines
3. Everything Under Control I. Regulated Transgene Expression in Mammalian Cells - Facts and Future
4. Secretion Engineering. The Traffic Jam getting out of the Cell
5. From Target To Market. An Antibody’s Journey From Cell Culture to Biology and Malign Applications. Do Life Sciences Enable the 7. Functional Food. Enjoy your Meal!
6. Industrial Genomics. Getting a Systems View on Nutrition and Health - An Industrial Perspective
7. IP Management - Food Technology. Protecting Your Knowledge For Business
9. 11. Biopharmaceutical Manufacturing II. Up- stream Development
10. Biopharmaceutical Manufacturing III. Downstream Development
11. Biopharmaceutical Manufacturing IV. Pharma Development

Lecture notes

Handsout during the course.

529-0004-00L Computer Simulation in Chemistry, Biology and Physics

W 7 credits 4G

P. H. Hünenberger
Abstract
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

For more information: www.csms.ethz.ch/education/CSCBP

Objective
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content
Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Lecture notes
Available (copies of powerpoint slides distributed before each lecture).

Literature
See: www.csms.ethz.ch/education/CSCBP

Prerequisites / notice
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/CSCBP

529-0241-00L
Advanced Methods and Strategies in Synthesis

W
7 credits
3G
J. W. Bode

Abstract
Advanced Modern Methods and Strategies in Synthesis

Objective
Knowledge of modern methods in asymmetric stereocentrocontrol, enantioselective catalysis, and organic reaction mechanisms.

Content
Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precipitants, and emerging topics will be emphasized.

Lecture notes
will be provided in class and online

Literature
Suggesting Textbooks

529-0233-00L
Organic Synthesis: Methods and Strategies

W
7 credits
3G
E. M. Carreira

Abstract
The complex relation between structural analysis, methods leading to desired transformations, and insight into reaction mechanisms is exemplified. Relations between retrosynthetic analysis of target structures, synthetic methods and their combination in a synthetic strategy.

Objective
Extension and deepening of the knowledge in organic synthesis.

Content

Literature

Prerequisites / notice
OC I-IV

529-0243-00L
Reactive Intermediates

W
7 credits
3G
P. Chen

Abstract
Advanced physical organic chemistry. Methods for the elucidation of reaction mechanisms. Reactive intermediates, Thermochemistry; isotope labeling; cross-over experiments; kinetic isotope effects; thermodynamics-kinetics correlations; solvation and ion pairs; radical reactions; electron transfer; spectroscopic methods.

Objective
Methods for the elucidation of organic reaction mechanisms.

Content

Lecture notes
A printed script are handed out in the course. This material is also available for download from the web page of the course (as pdf files).

Literature
Additional reading and original publications are cited in the lectures.

Prerequisites / notice
Required level: Courses in organic and physical chemistry of the first and second year. Each participant is expected to contribute to a 30 min. seminar (prepared by groups of 2-4 students), presented in the last weeks of the semester.

529-0041-00L
Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics

W
6 credits
3G
R. Zenobi, M. Badertscher, B. Hattendorf, P. Martinez-Lozano Sinues

Abstract
Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics.

Objective
Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

Content
Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation. Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods. Methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods). Employment of computer science for processing data in chemical analysis (chemometrics).

Lecture notes
lecture notes will be available in the lecture at production cost.

Literature
information about relevant literature will be available in the lecture & in the lecture notes.

Prerequisites / notice
Exercises are an integral part of the lecture.

551-1407-00L
RNA Biology Lecture Series I: Transcription & Processing & Translation

W
4 credits
2V
F. Allain, N. Ban, U. Kutay, further lecturers

Abstract
This course covers aspects of RNA biology related to gene expression at the posttranscriptional level. These include RNA transcription, processing, alternative splicing, editing, export and translation.

Objective
The students should obtain an understanding of these processes, which are at work during gene expression.

Content
Transcription & 3’end formation; splicing, alternative splicing, RNA editing; the ribosome & translation, translation regulation, RNP biogenesis & nuclear export, mRNA surveillance & mRNA turnover; signal transduction & RNA.

Prerequisites / notice
Basic knowledge of cell and molecular biology.
An advanced course on the synthesis, properties and function of peptides in chemistry and biology.

Knowledge of the synthesis, properties and function of peptides in chemistry and biology.

Advanced peptide synthesis, conformational properties, combinatorial chemistry, therapeutic peptides, peptide based materials, peptides in nanotechnology, peptides in asymmetric catalysis.

Citations from the original literature relevant to the individual lectures will be assigned weekly.


### Elective Concept Courses

#### Number Title
551-0307-00L Molecular and Structural Biology I: Protein Structure and Function

**Abstract**
Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

**Objective**
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytic.

**Literature Basics**
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.

#### Number Title
551-0319-00L Cellular Biochemistry (Part I)

**Abstract**
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

**Objective**
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer. Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes. Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

**Literature**
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

**Prerequisites / notice**
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

### Recommended Elective Courses (for all Master Majors)

#### Number Title
851-0180-00L Research Ethics

**Abstract**
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

**Objective**
The main goal of this course is to enhance the student’s ability to: recognize and identify ethical issues and conflicts, analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter. Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry
---------------------------------------
Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)
----------------------------------------------------------
Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

► Research Projects (for all Master Majors)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1801-00L</td>
<td>Research Project I</td>
<td>O</td>
<td>15 credits</td>
<td>34A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
Research projects, with themes from the chosen scientific fields of interest, are intended to familiarise candidates with scientific procedures and operational methodologies through supervised participation in current research work.
Master's Thesis

Abstract
Research projects, with themes from the chosen scientific fields of interest, are intended to familiarise candidates with scientific procedures and operational methodologies through supervised participation in current research work.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1800-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme;
c. have acquired at least 30 credits in the category "research projects".

Abstract
The Master research will be carried out on a theme in the chosen subject area and must be completed with a written report (Thesis) within six months.

Master's Examination

see Study Regulations 2006 for the Master-curriculum Biology, Art. 38

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1800-01L</td>
<td>Master's Examination</td>
<td>O</td>
<td>4</td>
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<td>Lecturers</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are admitted for the master examination:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract
The Master examination comprises a written part and an oral part. Both parts will receive an evaluation mark. The Master examination is passed when the arithmetic mean of both evaluation marks is at least 4. The Master examination must be taken within three months of submitting the thesis.

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-BIOL.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Biology Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
**Biomedical Engineering Master**

**Track Courses**
- Bioelectronics

**Track Core Courses**

During the Master program, a minimum of 12 CP must be obtained from track core courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Main topics of the course include: - Scaling laws at micro/nano scales - Electrostatics - Electromagnetism - Low Reynolds number flows - Observation tools - Materials and fabrication methods - Applications of biomedical microrobots</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>The powerpoint slides presented in the lectures will be made available in hard copy and as pdf files. Several readings will also be made available electronically.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>The lecture will be taught in English.</td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0605-00L</td>
<td>Nanosystems</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>A. Stemmer, J.N. Tisserant</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures. Special emphasis on the emerging field of molecular electronic devices.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Familiarize students with basic science and engineering principles governing the nano domain.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately. Special emphasis is placed on the emerging field of molecular electronic devices, their working principles, applications, and how they may be assembled. Topics are treated in 2 blocks: (I) From Quantum to Continuum: From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. (II) Interaction Forces on the Micro and Nano Scale: Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Course format: Lectures and Mini-Review presentations: Thursday 10-13, ML F 36</td>
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<tr>
<td><strong>Homework:</strong></td>
<td>Mini-Reviews</td>
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<tr>
<td>Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.</td>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0621-00L</td>
<td>Microsystems Technology</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>C. Hierold, M. Haluska</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and -devices by a sequence of defined processing steps (process flow).</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Students are introduced to the basics of micromachining and silicon process technology and will understand the fabrication of microsystems devices by the combination of unit process steps ( = process flow).</td>
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<tr>
<td><strong>Content</strong></td>
<td>- Introduction to microsystems technology (MST) and micro electro mechanical systems (MEMS) - Basic silicon technologies: Thermal oxidation, photolithography and etching, diffusion and ion implantation, thin film deposition. - Specific microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresistive materials. - Selected microsystems: Mechanical sensors and actuators, microresonators, thermal sensors and actuators, system integration and encapsulation.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Handouts (available online)</td>
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<tr>
<td><strong>Literature</strong></td>
<td>S.M. Sze: Semiconductor Devices, Physics and Technology</td>
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<tr>
<td></td>
<td>W. Menz, J. Mohr, O.Paul: Microsystem Technology</td>
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<td></td>
<td>G. Kovacs: Micromachined Transducer Sourcebook</td>
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</tbody>
</table>
Prerequisites / notice
Prerequisites: Physics I and II

227-0385-10L Biomedical Imaging W 6 credits 5G S. Kozerke, K. P. Prüssmann, M. Rudin

Abstract
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes
Lecture notes and handouts

Literature
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Prerequisites / notice
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

227-0386-00L Biomedical Engineering W 4 credits 3G J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong

Abstract
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Objective
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Content

Practical and theoretical exercises in small groups in the laboratory.

Lecture notes
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

AND
https://www1.ethz.ch/lbb/Education/BME

227-0393-10L Bioelectronics and Biosensors W 6 credits 2V+2U J. Vörös, M. F. Yanik, T. Zambelli

New course. Not to be confounded with 227-0393-00L last offered in the Spring Semester 2015.

Abstract
The course introduces the concepts of bioelectricity and biosensing. The sources and use of electrical fields and currents in the context of biological systems and problems are discussed. The fundamental challenges of measuring biological signals are introduced. The most important biosensing techniques and their physical concepts are introduced in a quantitative fashion.

Objective
During this course the students will:
- learn the basic concepts in biosensing and bioelectronics
- be able to solve typical problems in biosensing and bioelectronics
- learn about the remaining challenges in this field
Part I - Linear Signal Representation and Approximation: Hilbert spaces, LMMSE estimation, projection and estimation

The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

Introduction to Neuroinformatics

Signal and Information Processing: Modeling, Filtering, Learning

Objective

The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Content

This course considers the structure and function of biological neural networks at different levels. The function of neuronal networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

Literature

Pinsey and Barr, Bioelectricity: A Quantitative Approach (Third edition)

Prerequisites / notice

Supervised exercises solving real-world problems. Some Matlab based exercises in groups.

227-0427-00L Signal and Information Processing: Modeling, W 6 credits 4G H.A. Loeliger
Filtering, Learning

Abstract

Fundamentals in signal processing, detection/estimation, and machine learning.

I. Linear signal representation and approximation: Hilbert spaces, LMMSE estimation, regularization and sparsity.


Objective

The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

Content


227-1037-00L Introduction to Neuroinformatics W 6 credits 2V+1U K. A. Martin, M. Cook, V. Mante, M. Pfeiffer

Abstract

The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective

Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neuronal computation. The goal of this introductory course is to introduce the monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

Content

This course considers the structure and function of biological neural networks at different levels. The function of neuronal networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.
visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

Recommended Elective Courses

These courses are particularly recommended for the Bioelectronics track. Please consult your track advisor if you wish to select other subjects.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0166-00L</td>
<td>Analog Integrated Circuits</td>
<td>W</td>
<td>6</td>
<td>2+2</td>
<td>Q. Huang</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies. The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.</td>
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<tr>
<td>Objective</td>
<td>Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems.</td>
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<tr>
<td>Content</td>
<td>Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts of presented slides. No script but an accompanying textbook is recommended.</td>
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<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W</td>
<td>6</td>
<td>3+1</td>
<td>L. Van Gool, O. Göksele, E. Konukoglu</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction into methodology used in biomaterials research and application.</td>
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<tr>
<td>Objective</td>
<td>Handouts provided during the classes and references therein.</td>
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<tr>
<td>Content</td>
<td>Handouts can be accessed online.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Lecture notes of presented slides. No script but an accompanying textbook is recommended.</td>
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<tr>
<td>402-0674-00L</td>
<td>Physics in Medical Research: From Atoms to Cells</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>B. K. R. Müller</td>
</tr>
<tr>
<td>Objective</td>
<td>The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.</td>
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<tr>
<td>Content</td>
<td>As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.</td>
<td></td>
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</tr>
</tbody>
</table>
Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention. New methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

227-0468-00L Analog Signal Processing and Filtering Suitable for Master Students as Well as Doctoral Students.

Abstract
This lecture provides a wide overview over analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers.

Objective
This lecture provides a wide overview over analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers. The way the exam is done allows for the different interests of the two groups.

Content
At the beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during the whole term to analyze circuits and understand how signals propagate through them. The theory and CMOS implementation of active Filters is then discussed in detail using the example of Gm-C filters and active-RC filters. The ideal and nonideal behaviour of opamps, current conveyors, and inductor simulators follows. The link to the practical design of circuits and systems is done with an overview over different quality measures and figures of merit used in scientific literature and datasheets. Finally, an introduction to discrete-time and mixed-domain filters and circuits is given, including sensor read-out amplifiers, correlated double sampling, and chopping, and an introduction to sigma-delta A/D and D/A conversion on a system level.

Lecture notes
The base for these lectures are lecture notes and two or three published scientific papers. From these papers we will together develop the technical content.

Details: https://people.ee.ethz.ch/~haschmid/aswiki/

Prerequisites / notice
Some material is protected by password; students from ETHZ who are interested can write to haschmid@ethz.ch to ask for the password even if they do not attend the lecture.

Prerequisites: Recommended (but not required): Stochastic models and signal processing, Communication Electronics, Analog Integrated Circuits, Transmission Lines and Filters.

Knowledge of the Laplace transform and z transform and their interpretation (transfer functions, poles and zeros, bode diagrams, stability criteria …) and of the main properties of linear systems is necessary.

227-0981-00L Cross-Disciplinary Research and Development in Medicine and Engineering A maximum of 12 medical degree students and 12 (biomedical) engineering degree students can be admitted, their number should be equal.

Abstract
Cross-disciplinary collaboration between engineers and medical doctors is indispensable for innovation in health care. This course will bring together engineering students from ETH Zurich and medical students from the University of Zurich to experience the rewards and challenges of such interdisciplinary work in a project based learning environment.

Objective
The main goal of this course is to demonstrate the differences in communication between the fields of medicine and engineering. Since such differences become the most evident during actual collaborative work, the course is based on a current project in physiology research that combines medicine and engineering. For the engineering students, the specific aims of the course are to:

- Acquire a working understanding of the anatomy and physiology of the investigated system;
- Identify the engineering challenges in the project and communicate them to the medical students;
- Develop and implement, together with the medical students, solution strategies for the identified challenges;
- Present the found solutions to a cross-disciplinary audience.

Content
After a general introduction to interdisciplinary communication and detailed background on the collaborative project, the engineering students will receive tailored lectures on the anatomy and physiology of the relevant system. They will then team up with medical students who have received a basic introduction to engineering methodology to collaborate on said project. In the process, they will be coached both by lecturers from ETH Zurich and the University of Zurich, receiving lectures customized to the project. The course will end with each team presenting their solution to a cross-disciplinary audience.

Lecture notes
Handsont and relevant literature will be provided.

227-1033-00L Neuronorphic Engineering I

Abstract
This course covers analog circuits with emphasis on neuronorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

Objective
Understanding of the characteristics of neuronomorphic circuit elements.

Registration in this class requires the permission of the instructors. Class size will be limited to available lab spots. Preference is given to students that require this class as part of their major.

Prerequisites:
Course material Script, computer demonstrations, exercises and problem solutions

The course language is English.

Cross-Disciplinary Research and Development in Medicine and Engineering

Suitable for Master Students as Well as Doctoral Students.

Abstract
The main goal of this course is to demonstrate the differences in communication between the fields of medicine and engineering. Since such differences become the most evident during actual collaborative work, the course is based on a current project in physiology research that combines medicine and engineering. For the engineering students, the specific aims of the course are to:

- Acquire a working understanding of the anatomy and physiology of the investigated system;
- Identify the engineering challenges in the project and communicate them to the medical students;
- Develop and implement, together with the medical students, solution strategies for the identified challenges;
- Present the found solutions to a cross-disciplinary audience.

Content
After a general introduction to interdisciplinary communication and detailed background on the collaborative project, the engineering students will receive tailored lectures on the anatomy and physiology of the relevant system. They will then team up with medical students who have received a basic introduction to engineering methodology to collaborate on said project. In the process, they will be coached both by lecturers from ETH Zurich and the University of Zurich, receiving lectures customized to the project. The course will end with each team presenting their solution to a cross-disciplinary audience.

Lecture notes
Handsout and relevant literature will be provided.

Neuronorphic Engineering I

Abstract
This course covers analog circuits with emphasis on neuronorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

Objective
Understanding of the characteristics of neuronomorphic circuit elements.
Content

Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.


Prerequisites: Background in basics of semiconductor physics helpful, but not required.

227-2037-00L Physical Modelling and Simulation

Objective
This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

Content
Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.

Prerequisites / notice

151-0255-00L Energy Conversion and Transport in Biosystems

Abstract
Theory and application of thermodynamics and energy conversion in biological systems with focus on the cellular level.

Objective
Theory and application of energy conversion at the cellular level. Understanding of the basic features governing solutes transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes in the cell, generation of forces, work and relation to biomedical technologies.

Content
Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

Literature
Lecture notes and references therein.

151-0509-00L Microscale Acoustofluidics

Abstract
In this lecture the basics as well as practical aspects (from modelling to design and fabrication ) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

Objective
Understanding acoustophoresis, the design of devices and potential applications

Content
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity. Gorkov potential, numerical modelling, acoustics streaming, applications from ultrasonic microbronics to surface acoustic wave devices

Literature

Prerequisites / notice

Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

376-1103-00L Frontiers in Nanotechnology

Abstract
Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers

Objective
Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.

Content
The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Each lecturer will first give an overview of the state-of-the art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

Prerequisites / notice
All enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

376-1219-00L Rehabilitation Engineering II: Rehabilitation of

Abstract
Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived, to finally discussing biomedical applications and potential health issues. Scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

Lecture notes
All the enrollees will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

407-0647-00L Energy Conversion and Transport in Biosystems

Abstract
This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

Objective
Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.

Content
The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, linear equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetic-thermal analysis of MEMS.

In the second part of the course the students will work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.

151-0279-00L Microscale Acoustofluidics

Abstract
In this lecture the basics as well as practical aspects (from modelling to design and fabrication ) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

Objective
Understanding acoustophoresis, the design of devices and potential applications

Content
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity. Gorkov potential, numerical modelling, acoustics streaming, applications from ultrasonic microbronics to surface acoustic wave devices

Literature

Prerequisites / notice

Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.
Sensory and Vegetative Functions

L. Marchal Crespo

Abstract

Rehabilitation Engng is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective

Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

Content

Introduction, problem definition, overview

Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
- Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces

Literature

Introductory Books:


Selected Journal Articles and Web Links:
VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html
This course is an introduction to techniques in micro/nanotechnology and to microfluidics. It reviews how many familiar devices are built and can be used for research and biomedical applications. Transistors for DNA sequencing, beamers for patterning proteins, hard-disk technology for biosensing and scanning microfluidics for analyzing tissue sections are just a few examples of the covered topics.

The main objective of the course is to introduce micro/nanotechnology and microfluidics to students having a background in the life sciences. The course should familiarize the students with the techniques used in micro/nanotechnology and show them how micro/nanotechnology pervades throughout life sciences. Microfluidics will be emphasized due to their increasing importance in research and medical applications. The second objective is to have life students less intimidated by micro/nanotechnology and make them able to link instruments and techniques to specific problems that they might have in their projects/studies. This will also help students getting access to the ETHZ/IBM Nanotech Center infrastructure if needed.

Mostly formal lectures (2 x 45 min), with a 2 hour visit and introduction to cleanroom and micro/nanotechnology instruments, last 3 sessions would be dedicated to the presentation and evaluation of projects by students (3 students per team).

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

Number of participants limited to 30.

In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale. The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.

Specific topics in the course include, but not limited to:

1. Theoretical Concepts
   - Features of mass and thermal transport on the microscale
   - Key scaling laws
2. Microfluidic Device Manufacture
   - Conventional lithographic processing of rigid materials
   - Soft lithographic processing of plastics and polymers
   - Mass fabrication of polymeric devices
3. Unit operations and functional components
   - Analytical separations (electrophoresis and chromatography)
   - Chemical and biological synthesis
   - Sample preparation (filtration, SPE, pre-concentration)
   - Molecular detection
4. Design Workshop
   - Design of microfluidic architectures for PCR, distillation & mixing
5. Contemporary Applications in Biological Analysis
   - Microarrays
   - Cellular analyses (single cells, enzymatic assays, cell sorting)
   - Proteomics
6. System integration
   - Applications in radiochemistry, diagnostics and high-throughput experimentation

Lecture notes

Lecture handouts, background literature, problem sheets and notes will be provided electronically.

Micro/Nanotechnology and Microfluidics for Biomedical Applications

Biological Engineering and Biotechnology

Biopharmaceutical Manufacturing II. Upstream Development.

Biopharmaceutical Manufacturing III. Downstream Development.

Biomedical Applications

Biopharmaceutical Manufacturing

Biopharmaceutical Manufacturing II. Upstream Development.

Biopharmaceutical Manufacturing III. Downstream Development.

Biopharmaceutical Manufacturing IV. Pharma Development.

Biopharmaceutical Manufacturing I. Introduction to Process Development.

Biopharmaceutical Manufacturing II. Upstream Development.

Biopharmaceutical Manufacturing III. Downstream Development.

Biopharmaceutical Manufacturing IV. Pharma Development.

Biopharmaceutical Manufacturing

Biomedical Engineering and Biotechnology

Biomedical Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.

Survival Pathways To Increase Robustness of Production Cell Lines.

Everything Under Control I. Regulated Transgene Expression in Mammalian Cells - Facts and Future.

Secretion Engineering. The Traffic Jam getting out of the Cell.

Development of Biological Weapons?

Industrial Genomics. Getting a Systems View on Nutrition and Health - An Industrial Perspective.


IMPE - Food Technology - Protecting Your Knowledge For Business.

Biopharmaceutical Manufacturing I. Introduction to Process Development.

Biopharmaceutical Manufacturing II. Upstream Development.

Biopharmaceutical Manufacturing III. Downstream Development.

Biopharmaceutical Manufacturing IV. Pharma Development.

Handout during the course.

Physiology and Anatomy for Biomedical Engineers I

This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance imaging.

To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.
The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology.

Scripts of all lectures will be available.

Biomedical Engineering

The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

The course during 4 afternoons (13h to 18h) covers basic laboratory skills and safety, cell culture, protein analysis, RNA/DNA Isolation and vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.

Content
- The Human Body: nomenclature, orientations, tissues
- Musculoskeletal system, Muscle contraction
- Blood vessels, Heart, Circulation
- Blood, Immune system
- Respiratory system
- Acid-Base-Homeostasis

Lecture notes
Lecture notes and handouts

Literature
Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thieme 2008
Faller A., Schuenike M. The Human Body; Thieme 2004
Netter F. Atlas of human anatomy; Elsevier 2014

227-0945-00L Cell and Molecular Biology for Engineers I

This course is part I of a two-semester course.

The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

Abstract

Objective

Content

Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.

Lecture notes
Scripts of all lectures will be available.

Literature

227-0949-00L Biological Methods for Engineers (Basic Lab)

Limited number of participants.

The course during 4 afternoons (13h to 18h) covers basic laboratory skills and safety, cell culture, protein analysis, RNA/DNA Isolation and RT-PCR. Each topic will be introduced, followed by practical work at the bench. Presence during the course is mandatory.

Objective

Content

Prerequisites / notice
Enrollment is limited and students from the Master's programme in Biomedical Engineering (BME) have priority.
The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

Synchrontron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The course provides the necessary background to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

Recommended Elective Courses

These courses are particularly recommended for the Bioimaging track. Please consult your track advisor if you wish to select other subjects.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0389-00L</td>
<td>Advanced Topics in Magnetic Resonance Imaging</td>
<td>Z</td>
<td>0</td>
<td>1V</td>
<td>K. P. Prüssmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is geared towards master and PhD students with a focus on bioimaging. It covers advanced topics in magnetic resonance imaging in biennial rotation, including the electrodynamics of MR signal detection, noise mechanisms, image reconstruction, radiofrequency pulse design, RF pulse trains, as well as advanced contrast mechanisms.</td>
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<td>Objective</td>
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<td>227-0391-00L</td>
<td>Medical Image Analysis</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. C. Cattin, M. A. Reyes Aguirre</td>
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<tr>
<td>Abstract</td>
<td>It is the objective of this lecture to introduce the basic concepts used in Medical Image Analysis. In particular the lecture focuses on shape representation schemes, segmentation techniques, and the various image registration methods commonly used in Medical Image Analysis applications.</td>
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<tr>
<td>Objective</td>
<td>This lecture aims to give an overview of the basic concepts of Medical Image Analysis and its application areas. Basic knowledge of computer vision would be helpful.</td>
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<tr>
<td>Prerequisites / notice</td>
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<tr>
<td>227-0455-00L</td>
<td>Terahertz: Technology &amp; Applications</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>K. Sankaran</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting.</td>
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<tr>
<td>Objective</td>
<td>This is an introductory course on Terahertz (THz) technology and applications. Devices operating in THz frequency range (0.1 to 10 THz) have been increasingly studied in the recent years. Progress in nonlinear optical materials, ultrafast optical and electronic techniques has strengthened research in THz application developments. Due to unique interaction of THz waves with materials, applications with new capabilities can be developed. In theory, they can penetrate somewhat like X-rays, but are not considered harmful radiation, because THz energy level is low. They should be able to provide resolution as good or better than magnetic resonance imaging (MRI), possibly with simpler equipment. Imaging, very-high bandwidth communication, and energy harvesting are the most widely explored THz application areas. We will study the basics of THz generation, manipulation, and detection. Our emphasis will be on the physical principles and applications of THz in the domain of imaging, communication and energy harvesting.</td>
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E. Konukoglu
INTRODUCTION
Chapter 1: Introduction to THz Physics
Chapter 2: Components of THz Technology

THz TECHNOLOGY MODULES
Chapter 3: THz Generation
Chapter 4: THz Detection
Chapter 5: THz Manipulation

APPLICATIONS
Chapter 6: THz Imaging
Chapter 7: THz Communication
Chapter 8: THz Energy Harvesting

K. E. Stephan

Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization.

This course teaches methods and models for fMRI data analysis, covering all aspects of statistical parametric mapping (SPM), incl.
1. Consolidation of theoretical knowledge (obtained in the following courses: 'Methods & models for fMRI data analysis', 'Translational Neuromodeling', 'Computational Psychiatry') in a practical setting.
2. Acquisition of practical problem solving strategies for computational modeling of neuroimaging data.

Prerequisites / notice
The participants are expected to have successfully completed at least one of the following courses:
'Methods & models for fMRI data analysis',
'Translational Neuromodeling',
'Computational Psychiatry'

227-0967-00L
Computational Neuroimaging Clinic
Prerequisite: Successful completion of course "Methods & Models for fMRI Data Analysis" (227-0969-00L).

Abstract
This seminar teaches problem solving skills for computational neuroimaging, based on joint analyses of neuroimaging and behavioural data. It deals with a wide variety of real-life problems that are brought to this meeting from the neuroimaging community at Zurich, e.g. mass-univariate and multivariate analyses of fMRI/EEG data, or generative models of fMRI, EEG, or behavioural data.

Objective
1. Consolidation of theoretical knowledge (obtained in the following courses: 'Methods & models for fMRI data analysis', 'Translational Neuromodeling', 'Computational Psychiatry') in a practical setting.
2. Acquisition of practical problem solving strategies for computational modeling of neuroimaging data.

227-0969-00L
Methods & Models for fMRI Data Analysis

Abstract
This course teaches state-of-the-art methods and models for fMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, statistical inference, multiple comparison corrections, event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data.

Objective
To obtain in-depth knowledge of the theoretical foundations of SPM and DCM and of their application to empirical fMRI data.

Content
This course teaches state-of-the-art methods and models for fMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, frequentist and Bayesian inference, multiple comparison corrections, and event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data. A particular emphasis of the course will be on methodological questions arising in the context of studies in psychology, neurology and neuropsychology.

227-0971-00L
Computational Psychiatry

Abstract
This five-day course teaches state-of-the-art methods in computational psychiatry. It covers various computational models of cognition (e.g., learning and decision-making) and brain physiology (e.g., effective connectivity) of relevance for psychiatric disorders. The course not only provides theoretical background, but also demonstrates open source software in application to concrete examples.

Objective
This course aims at bridging the gap between mathematical modelers and clinical neuroscientists by teaching computational techniques in the context of clinical applications. The hope is that the acquisition of a joint language and tool-kit will enable more effective communication and joint translational work between fields that are usually worlds apart.

Content
This five-day course teaches state-of-the-art methods in computational psychiatry. It covers various computational models of cognition (e.g., learning and decision-making) and brain physiology (e.g., effective connectivity) of relevance for psychiatric disorders. The course not only provides theoretical background, but also demonstrates open source software in application to concrete examples.

227-2037-00L
Physical Modelling and Simulation

Abstract
This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

Objective
Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.

Content
The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, linear equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetic-thermal analysis of MEMS.

In the second part of the course the students will work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.

151-0105-00L
Quantitative Flow Visualization

Abstract
The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.

Objective
Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization. Understanding of hardware and software requirements and solutions.

Development of basic programming skills for (generic) imaging applications.
Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient.

**Objective**

Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation.

**Content**

Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

**Target Group:**

Students of higher semesters and PhD students of:
- D-HEST, D-MAVT, D-ITET, D-INFK, D-PHYS
- Robotics, Systems and Control Master
- Biomedical Engineering/Movement Science and Sport
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome!

**Literature**


More details will be announced in the lecture.

**Prerequisites / notice**

Prerequisites: Fluiddynamics I, Numerical Mathematics, programming skills.
Language: German on request.

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**Virtual Reality in Medicine**

**W 3 credits 2V R. Rienner**

**Abstract**

Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (audiovisual, haptic, tactile etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

**Objective**

Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

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Students of other departments, faculties, courses are also welcome!

**Literature**


More details will be announced in the lecture.

**Prerequisites / notice**

Prerequisites: Fluiddynamics I, Numerical Mathematics, programming skills.
Language: German on request.
This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.

**Lecture notes**

**Prerequisites / notice**

Prerequisites: Fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, programming skills in C++, Visual Computing course recommended.

The programming assignments will be in C++. This will not be taught in the class.

**402-0674-00L Physics in Medical Research: From Atoms to Cells**

**Abstract**

Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

**Objective**

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinetic theory and perfectly understood by means of Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

**227-1033-00L Neuroromphic Engineering I**

**Registration**

This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

**Objective**

Understanding the characteristics of neuromorphic circuit elements.

**Content**

Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

**Literature**

S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

**Prerequisites / notice**

Particular: The course is highly recommended for those who intend to take the spring semester course 'Neuromorphic Engineering II', that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

**227-1037-00L Introduction to Neuroinformatics**

**Abstract**

The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

**Objective**

Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocolures of physics, math, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.
This course considers the structure and function of biological neural networks at different levels. The focus of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

### Introduction to Bioinformatics: Concepts and Applications

This course is part I of a two-semester course. Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

**Number** 227-0945-00L  
**Title** Cell and Molecular Biology for Engineers I  
**Type** W  
**ECTS** 3 credits  
**Hours** 3G  
**Lecturers** C. Frei

**Abstract**  
The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

**Objective**  
After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

**Content**  
Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytokskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience. The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology. Light and perception. Digital image formation. Image enhancement and feature extraction. Unitary transformations. Color and texture.

Prerequisites / notice
Enrollment is limited and students from the Master's programme in Biomedical Engineering (BME) have priority.

### Biomechanics

#### Track Core Courses

During the Master program, a minimum of 12 CP must be obtained from track core courses.

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<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kazerke, K. P. Prüßmann, M. Rudin</td>
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<tr>
<td></td>
<td>Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.</td>
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<td></td>
<td>To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes and handouts</td>
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<tr>
<td>Literature</td>
<td>Webb A, Smith N.B. Introduction to Medical Imaging; Physics, Engineering and Clinical Applications; Cambridge University Press 2011</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming</td>
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<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Vörös, S. J. Ferguson, S. Kazerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
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<tr>
<td></td>
<td>Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.</td>
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<td>Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.</td>
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<tr>
<td>Lecture notes</td>
<td>Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino</td>
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<tr>
<td>Literature</td>
<td><a href="https://www1.ethz.ch/lbb/Education/BME">https://www1.ethz.ch/lbb/Education/BME</a></td>
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<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W</td>
<td>6</td>
<td>3V+1U</td>
<td>L. Van Gool, O. Göksel, E. Konukoglu</td>
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<tr>
<td></td>
<td>Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.</td>
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<td>Prerequisites / notice</td>
<td>Course material Script, computer demonstrations, exercises and problem solutions</td>
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<tr>
<td>227-0965-00L</td>
<td>Micro and Nano-Tomography of Biological Tissues</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Stampanoni, P. A. Kaestner</td>
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Lecture notes and references therein.

Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and clinical and movement biomechanics.

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course concludes with an introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The lecture concludes by discussing the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture concludes by discussing the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

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Lecture notes and references therein.

Clinical and Movement Biomechanics

Measurement and modeling of the human movement during daily activities and in a clinical environment.

The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.

This course includes study design, measurement techniques, clinical testing, accessing movement data and anaysis as well as modeling with regards to human movement.

Trauma Biomechanics

Trauma biomechanics in an interdisciplinary research field investigating the biomechanics of injuries and related subjects such as prevention. The lecture provides an introduction to the basic principles of trauma biomechanics.

Introduction to the basic principles of trauma biomechanics.

This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact biomechanics, which uses the combination of fundamental engineering principles and advanced medical technologies to develop injury prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite element modelling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real world examples mainly from automobile safety are used to augment lecture material.

Handouts will be made available.

Recommended Elective Courses

These courses are particularly recommended for the Biomechanics track. Please consult your track advisor if you wish to select other subjects.

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<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4 credits</td>
<td>2+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
<tr>
<td>151-0524-00L</td>
<td>Continuum Mechanics I</td>
<td>W</td>
<td>4 credits</td>
<td>2+1U</td>
<td>E. Mazza</td>
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<tr>
<td>151-0604-00L</td>
<td>Micro robotics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>B. Nelson</td>
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The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

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<td>Continuum Mechanics I</td>
<td>W</td>
<td>4 credits</td>
<td>2+1U</td>
<td>E. Mazza</td>
</tr>
<tr>
<td>151-0604-00L</td>
<td>Micro robotics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
</tbody>
</table>

The lecture concludes by discussing the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

Lecture notes and references therein.

Clinical and Movement Biomechanics

Measurement and modeling of the human movement during daily activities and in a clinical environment.

The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.

This course includes study design, measurement techniques, clinical testing, accessing movement data and anaysis as well as modeling with regards to human movement.

Trauma Biomechanics

Trauma biomechanics in an interdisciplinary research field investigating the biomechanics of injuries and related subjects such as prevention. The lecture provides an introduction to the basic principles of trauma biomechanics.

Introduction to the basic principles of trauma biomechanics.

This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact biomechanics, which uses the combination of fundamental engineering principles and advanced medical technologies to develop injury prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite element modelling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real world examples mainly from automobile safety are used to augment lecture material.

Handouts will be made available.

Recommended Elective Courses

These courses are particularly recommended for the Biomechanics track. Please consult your track advisor if you wish to select other subjects.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4 credits</td>
<td>2+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
<tr>
<td>151-0524-00L</td>
<td>Continuum Mechanics I</td>
<td>W</td>
<td>4 credits</td>
<td>2+1U</td>
<td>E. Mazza</td>
</tr>
<tr>
<td>151-0604-00L</td>
<td>Micro robotics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
</tbody>
</table>
151-0605-00L Nanosystems W 4 credits 4G A. Stemmer, J.N. Tisserant

**Abstract**
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.

Special emphasis is placed on the emerging field of molecular electronic devices.

**Objective**
Familiarize students with basic science and engineering principles governing the nano domain.

**Content**
The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

Special emphasis is placed on the emerging field of molecular electronic devices, their working principles, applications, and how they may be assembled.

Topics are treated in 2 blocks:

(I) From Quantum to Continuum
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale
Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.

Self-assembly and directed assembly of 2D and 3D structures.

**Literature**

**Prerequisites / notice**
Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

**Homework:** Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

227-2037-00L Physical Modelling and Simulation W 5 credits 4G C. Hafner, J. Leuthold, J. Smajic

**Abstract**
This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics, and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

**Objective**
Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.

**Content**
The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, boundary value problems in MEMS. In the second part of the course the students work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.

**Prerequisites / notice**
Course format:
Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

**Homework:** Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

263-5001-00L Introduction to Finite Elements and Sparse Linear System Solving W 4 credits 2V+1U P. Arbenz

**Abstract**
The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that a typical for the FE method. We will consider direct and iterative methods.

**Objective**
Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.
Content

I. THE FINITE ELEMENT METHOD

(1) Introduction, model problems.
(2) 1D problems. Piecewise polynomials in 1D.
(3) 2D problems. Triangulations. Piecewise polynomials in 2D.
(4) Variational formulations. Galerkin finite element method.
(5) Implementation aspects.

II. DIRECT SOLUTION METHODS

(6) LU and Cholesky decomposition.
(7) Sparse matrices.
(8) Fill-reducing orderings.

III. ITERATIVE SOLUTION METHODS

(9) Stationary iterative methods, preconditioning.
(10) Preconditioned conjugate gradient method (PCG).
(11) Incomplete factorization preconditioning.
(12) Multigrid preconditioning.
(13) Nonsymmetric problems (GMRES, BiCGstab).
(14) Indefinite problems (SYMMLQ, MINRES).

Literature


Prerequisites / notice

Prerequisites: Linear Algebra, Analysis, Computational Science.
The exercises are made with Matlab.

Abstract

Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.

Objective

Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.

The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Each lecturer will first give an overview of the state-of-the-art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

Content

Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what biospired engineering principles can be derived, to finally discussing biomedical applications and potential health risk issues. Scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

Lecture notes

All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

Abstract

Rehabilitation Engng is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective

Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.
Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces

Literature

Introductory Books:


Selected Journal Articles and Web Links:

Prerequisites / notice
VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/ videotac.html
Target Group:
Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich
Students of other departments, faculties, courses are also welcome
This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.
Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy. This lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Target Group:
Students of higher semesters and PhD students of:
- D-HEST, D-MAVT, D-ITET, D-INFK, D-PHY
- Robotics, Systems and Control Master
- Biomedical Engineering/Movement Science and Sport
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome!


The course language is English. Basic experience in Information Technology and Computer Science will be of advantage.

More details will be announced in the lecture.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Seminar</th>
<th>Lecturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1714-00L</td>
<td>Bio-compatible Materials</td>
<td>W 4</td>
<td>G</td>
<td>K. Maniura, J. Möller, M. Zenobi-Wong</td>
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<tr>
<td></td>
<td>Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.</td>
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<td></td>
<td>The class consists of three parts: 1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials. 2. The concept of biocompatibility. 3. Introduction into methodology used in biomaterials research and application.</td>
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<tr>
<td></td>
<td>Literature</td>
<td>Handouts can be accessed online.</td>
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<tr>
<td></td>
<td>Handouts provided during the classes and references therein.</td>
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<tr>
<td>376-1351-00L</td>
<td>Micro/Nanotechnology and Microfluidics for Biomedical Applications</td>
<td>W 2</td>
<td>V</td>
<td>E. Delamarche</td>
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<tr>
<td></td>
<td>This course is an introduction to techniques in micro/nanotechnology and to microfluidics. It reviews how many familiar devices are built and can be used for research and biomedical applications. Transistors for DNA sequencing, bearers for patterning proteins, hard-disk technology for biosensing and scanning microfluidics for analyzing tissue sections are just a few examples of the covered topics.</td>
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<td>The main objective of the course is to introduce micro/nanotechnology and microfluidics to students having a background in the life sciences. The course should familiarize the students with the techniques used in micro/nanotechnology and show them how micro/nanotechnology pervades throughout life sciences. Microfluidics will be emphasized due to their increasing importance in research and medical applications. The second objective is to have life students less intimidated by micro/nanotechnology and make them able to link instruments and techniques to specific problems that they might have in their projects/studies. This will also help students getting access to the ETHZ/IBM Nanotech Center infrastructure if needed.</td>
<td>Mostly formal lectures (2 × 45 min), with a 2 hour visit and introduction to cleanroom and micro/nanotechnology instruments, last 3 sessions would be dedicated to the presentation and evaluation of projects by students (3 students per team).</td>
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<tr>
<td></td>
<td>Literature</td>
<td>Handouts can be accessed online.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>376-1720-00L</td>
<td>Application of MATLAB in the Human Movement</td>
<td>W 2</td>
<td>G</td>
<td>R. van de Langenberg</td>
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<td></td>
<td>Students will learn to import, process and graphically present experimental data using the MATLAB computing environment. Both the data and the methods of analysis will be typical for experiments in Human Movement Science (i.e. kinematics, kinetics and electromyography).</td>
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<td></td>
<td>Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromyographical data using the MATLAB computing environment.</td>
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<tr>
<td></td>
<td>Literature</td>
<td>During the lecture, several electronically available MATLAB introductions are indicated. Course-specific scripts will be provided by the lecturer.</td>
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<tr>
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<td>Prerequisites / notice</td>
<td>A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.</td>
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<td></td>
<td>Current topics in biomechanics presented by speakers from academia and industry.</td>
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<tr>
<td></td>
<td>Objective</td>
<td>Getting insight into actual areas and problems of biomechanics.</td>
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</tbody>
</table>
Biomechanics of Sports Injuries and Rehabilitation

**Abstract**

This lecture introduces the basic principles of injury mechanics and rehabilitation focussing on sports injuries. Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

**Objective**

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein adsorption/activity and monocye behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

**Prerequisites / notice**

A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

**Handouts**

A script will be provided.

**Literature**


**Keywords**

Biomechanics; Trauma; Dynamics; Biophysics.
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

**Bioinformatics I** will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

### Biology Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0399-10L</td>
<td><strong>Physiology and Anatomy for Biomedical Engineers I</strong></td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>H. Niemann</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance imaging.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.</td>
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</tr>
</tbody>
</table>
| **Content**     | - The Human Body: nomenclature, orientations, tissues  
- Musculoskeletal system, Muscle contraction  
- Blood vessels, Heart, Circulation  
- Blood, Immune system  
- Respiratory system  
- Acid-Base-Homeostasis  |
| **Lecture notes** | Lecture notes and handouts |
| **Literature**  | Silbernagli S., Despopoulos A. Color Atlas of Physiology; Thieme 2008  
Faller A., Schuenke M. The Human Body; Thieme 2004  
Netter F. Atlas of human anatomy; Elsevier 2014 |

| 227-0945-00L    | **Cell and Molecular Biology for Engineers I** | W    | 3    | 3G    | C. Frei              |
| **Abstract**    | The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology. |
| **Objective**   | After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested. |
| **Content**     | Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytokkeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.  
In addition, three journal clubs will be held, where one/two publictions will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade. |
| **Lecture notes** | Scripts of all lectures will be available. |

| 227-0949-00L    | **Biological Methods for Engineers (Basic Lab)** | W    | 2    | 4P    | C. Frei              |
| **Abstract**    | **Limited number of participants.**  
The course during 4 afternoons (13h to 18h) covers basic laboratory skills and safety, cell culture, protein analysis, RNA/DNA Isolation and RT-PCR. Each topic will be introduced, followed by practical work at the bench. Presence during the course is mandatory. |
| **Objective**   | The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology. |
| **Content**     | The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology. |
| **Prerequisites / notice** | Enrollment is limited and students from the Master's programme in Biomedical Engineering (BME) have priority. |

### Medical Physics

### Track Core Courses

During the Master program, a minimum of 12 CP must be obtained from track core courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0385-10L</td>
<td><strong>Biomedical Imaging</strong></td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kozserke, K. P. Prüssmann, M. Rudin</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.</td>
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</tbody>
</table>
Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes
Lecture notes and handouts

Literature
Webb A, Smith N.B. Introduction to Medical Imaging; Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Prerequisites / notice
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

402-0341-00L
Medical Physics I

Abstract
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiologically and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations. 

Objective
Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.

Content
- The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the exercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

Lecture notes
A script will be provided.

402-0345-00L
Introduction to Medical Physics

Abstract
Medical physics is a fascinating and worthwhile scientific discipline, providing many professional opportunities to apply physics to the care of patients, either in the clinic or in industry. It is also an area allowing for exciting, interesting and fulfilling areas of research.

Objective
It is the aim of this course to give bachelor and master level students an insight into the wide spectrum of medical applications of physics, and to provide some insight into the work of the medical physicist in clinics, industry and research.

Content
- The lecture series will begin with a short historical overview of medical physics and an overview of the lecture series (lecture 1). This will be followed by two lectures on the physics of medical imaging. Medical imaging is one of the most important areas of preventative medicine and diagnostics, and in these two lectures, we will summarise the physics aspects of all the most important medical imaging modalities (X-ray, computed tomography, CT, MRI, Ultrasound imaging etc.). With lectures 4 and 5, we will move onto one of the other major areas of physics applied to medicine, radiotherapy. As the name implies, this is a physics ‘heavy’ discipline, being dependent as it is on both accelerator and particle physics. However, what is less well known is that this is also the second most successful treatment of cancer after surgery and a great success story for the application of physics to medicine. In lectures 6 and 7 we will then move on to a very different area, that of bio-photonics and bio-physics. Here we will look into the applications of lasers in medicine, from therapy to their use in particle acceleration for medical applications, as well as a variety of optical techniques for studying biological tissues, cells and structures.

In the second half of the lecture series (lectures 8-13) the style changes somewhat, and we will concentrate on professional aspects of medical physics and the role of the medical physicist in various professional scenarios. As such, lectures 8-11 will cover the role of the clinical medical physicist in diagnostic radiology, MRI, nuclear medicine and radiotherapy, whilst the last two lectures will concentrate on their role in industry and research. For many of this second set of lectures, external experts in the various areas will be invited in order to give the student the best possible insight into the life of a professional medical physicist.

227-0943-00L
Radiobiology

Abstract
The purpose of this course is to impart basic knowledge in radiobiology in order to handle ionizing radiation and to provide a basis for predicting the radiation risk.

Objective
By the end of this course the participants will be able to:
- interpret the 5 Rs of radiation oncology in the context of the hallmarks of cancer
- understand factors which underpin the differing radiosensitivities of different tumors
- follow rational strategies for combined treatment modalities of ionizing radiation with targeted agents
- understand differences in the radiation response of normal tissue versus tumor tissue
- understand different treatment responses of the tumor and the normal tissue to differential clinical-related parameters of radiotherapy (dose rate, LET etc.).

Content
- Einführung in die Strahlenbiologie ionisierender Strahlen: Allgemeine Grundlagen und Begriffsbestimmungen; Mechanismen der biologischen Strahlenwirkung: Strahlenwirkung auf Zellen, Gewebe und Organe; Radioaktivität; Strahlenzytogenetik: Chromosomenveränderungen, DNA-Defekte, Reparaturprozesse; Molekulare Strahlenbiologie: Bedeutung inter- und intrazellulärer Signalkettenprozesse, Apoptose, Zellzyklus-Checkpoints; Strahlenrisiko: Strahlenschutz, Krebsinduierung, Mutationsauslösung, präklinische Strahlenwirkung; Strahlenbiologische Grundlagen des Strahlenschutzes; Nutzen-Risiko-Abwägungen bei der medizinischen Strahlenanwendung; Prädiktive strahlenbiologische Methoden zur Optimierung der therapeutischen Strahlenanwendung.

Lecture notes
Beilagen mit zusammenfassenden Texten, Tabellen, Bild- und Grafikdarstellungen werden abgegeben

Literature

Prerequisites / notice
The former number of this course unit is 465-0951-00L.

Recommended Elective Courses

These courses are particularly recommended for the Medical Physics track. Please consult your track advisor if you wish to select other subjects.

<table>
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<tr>
<th>Number</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0674-00L</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>2</td>
<td>B. K. R. Müller</td>
</tr>
</tbody>
</table>

Abstract
Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

### Other Elective Courses

*These courses may be suitable for the Medical Physics track. Please consult your track advisor.*

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0447-00L</td>
<td><strong>Image Analysis and Computer Vision</strong></td>
<td>W</td>
<td>6 credits</td>
<td>3V+1U</td>
<td>L. Van Gool, O. Göksel, E. Konukoglu</td>
</tr>
<tr>
<td>227-0965-00L</td>
<td><strong>Micro and Nano-Tomography of Biological Tissues</strong></td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Stamparoni, P. A. Kaestner</td>
</tr>
<tr>
<td>227-0399-10L</td>
<td><strong>Physiology and Anatomy for Biomedical Engineers I</strong></td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>H. Niemann</td>
</tr>
</tbody>
</table>

### Literature

- Will be indicated during the lecture.
- Available online
- Course material Script, computer demonstrations, exercises and problem solutions
- Prerequisites:
  - Basic concepts of mathematical analysis and linear algebra.
  - The computer exercises are based on Linux and C.
  - The course language is English.

### Visiting Clinical Research

- Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.
Abstract
This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance imaging.

Objective
To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.

Content
- The Human Body: nomenclature, orientations, tissues
- Musculoskeletal system, Muscle contraction
- Blood vessels, Heart, Circulation
- Blood, Immune system
- Respiratory system
- Acid-Base-Homeostasis

Lecture notes
Lecture notes and handouts

Literature
Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thieme 2008
Faller A., Schuenike M. The Human Body; Thieme 2004
Netter F. Atlas of human anatomy; Elsevier 2014

227-0945-00L Cell and Molecular Biology for Engineers I
This course is part I of a two-semester course.

Abstract
The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

Objective
After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

Content
Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.

Lecture notes
Scripts of all lectures will be available.

Literature

★★★ Molecular Bioengineering
★★★ Track Core Courses
During the Master program, a minimum of 12 CP must be obtained from track core courses.

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>376-1103-00L</td>
<td>Frontiers in Nanotechnology</td>
<td>W</td>
<td>4</td>
<td>4V</td>
<td>V. Vogel, further lecturers</td>
</tr>
</tbody>
</table>

Abstract
Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.

Objective
Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.

Content
Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived to finally discussing biomedical applications and potential health risk issues. Scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

Lecture notes
All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>376-1714-00L</td>
<td>Biocompatible Materials</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>K. Maniura, J. Möller, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes
Handouts can be accessed online.
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, and protein.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

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3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

### 465-0953-00L Biostatistics

**W** 4 credits 2V+1U B. Sick

**Abstract**

The course deals with simple quantitative and graphical as well as more complex methods of biostatistics. Contents: Descriptive statistics, probability theory and design of experiments, testing hypotheses, confidence intervals, correlation, simple and multiple linear regression, classification and prediction, diagnostic tests, measurement of agreement.

### 551-0103-00L Fundamentals of Biology II: Cell Biology

**W** 5 credits 5V E. Hafen, U. Kutaj, J. Matos, G. Schertler, U. Suter, S. Werner

**Abstract**

The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

**Objective**

The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

**Content**

The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

**Lecture notes**

The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the netzh (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.

**Literature**


**Prerequisites / notice**

Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.

### 551-1295-00L Introduction to Bioinformatics: Concepts and Applications

**W** 6 credits 4G W. Gruissem, K. Bärenfaller, A. Callisch, G. Capitani, J. Fütterer, M. Robinson, A. Wagner

**Abstract**

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.
Objective

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

636-0003-00L  
**Biological Engineering and Biotechnology**  
W  6 credits  3V  M. Fussenegger

Abstract

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Objective

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines
3. Everything Under Control I. Regulated Transgene Expression in Mammalian Cells - Facts and Future
4. Secretion Engineering. The Traffic Jam getting out of the Cell
5. From Target To Market. An Antibody's Journey From Cell Culture to The Clinics
6. Biology and Malign Applications. Do Life Sciences Enable the Development of Biological Weapons?
7. Functional Food. Enjoy your Meal!
8. Industrial Genomics. Getting a Systems View on Nutrition and Health - An Industrial Perspective
9. IP Management - Food Technology. Protecting Your Knowledge For Business
10. Biopharmaceutical Manufacturing I. Introduction to Process Development
11. Biopharmaceutical Manufacturing II. Up-stream Development
12. Biopharmaceutical Manufacturing III. Downstream Development
13. Biopharmaceutical Manufacturing IV. Pharma Development

Lecture notes

Handsout during the course.

Recommended Elective Courses

These courses are particularly recommended for the Molecular Bioengineering track. Please consult your track advisor if you wish to select other subjects.

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<th>Number</th>
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<th>ECTS</th>
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<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Nelson</td>
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<td></td>
<td>Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.</td>
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<td>The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.</td>
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<td>Main topics of the course include:</td>
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<td></td>
<td>- Scaling laws at micro/nano scales</td>
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<td></td>
<td>- Electrostatics</td>
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<td>- Electromagnetism</td>
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<td>- Low Reynolds number flows</td>
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<td></td>
<td>- Observation tools</td>
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<td>- Materials and fabrication methods</td>
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<td>- Applications of biomedical microrobots</td>
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<td></td>
<td>The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.</td>
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<td>The lecture will be taught in English.</td>
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<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kozerke, K. P. Prüssmann, M. Rudin</td>
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<tr>
<td></td>
<td>Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.</td>
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<tr>
<td></td>
<td>To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.</td>
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<td>The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.</td>
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</table>
Abstract
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Objective
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Content

Prerequisites / notice
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

227-0393-10L  Bioelectronics and Biosensors  W  6 credits  2V+2U  J. Vörös, M. F. Yanik, T. Zambelli
Abstract
The course introduces the concepts of bioelectricity and biosensing. The sources and use of electrical fields and currents in the context of biological systems and problems are discussed. The fundamental challenges of measuring biological signals are introduced. The most important biosensing techniques and their physical concepts are introduced in a quantitative fashion.

Objective
During this course the students will:
- learn the basic concepts in biosensing and bioelectronics
- be able to solve typical problems in biosensing and bioelectronics
- learn about the remaining challenges in this field

Content
L1. Bioelectronics history, its applications and overview of the field
- Volta and Galvani dispute
- BMI, pacemaker, cochlear implant, retinal implant, limb replacement devices
- Fundamentals of biosensing
- Glucometer and ELISA

L2. Fundamentals of quantum and classical noise in measuring biological signals

L3. Biomasurement techniques with photons

L4. Acoustics sensors
- Differential equation for quartz crystal resonance
- Acoustic sensors and their applications

L5. Engineering principles of optical probes for measuring and manipulating molecular and cellular processes

L6. Optical biosensors
- Differential equation for optical waveguides
- Optical sensors and their applications
- Plasmonic sensing

L7. Basic notions of molecular adsorption and electron transfer
- Quantum mechanics: Schrödinger equation energy levels from H atom to crystals, energy bands
- Electron transfer: Marcus theory, Gerischer theory

L8. Potentiometric sensors
- Fundamentals of the electrochemical cell at equilibrium (Nernst equation)
- Principles of operation of ion-selective electrodes

L9. Amperometric sensors and bioelectric potentials
- Fundamentals of the electrochemical cell with an applied overpotential to generate a faraday current
- Principles of operation of amperometric sensors
- Ion flow through a membrane (Fick equation, Nernst equation, Donnan equilibrium, Goldman equation)

L10. Channels, amplification, signal gating, and patch clamp Y4

L11. Action potentials and impulse propagation

L12. Functional electric stimulation and recording
- MEA and CMOS based recording
- Applying potential in liquid - simulation of fields and relevance to electric stimulation

L13. Neural networks memory and learning

Literature
Plonsey and Barr, Bioelectricity: A Quantitative Approach (Third edition)
To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to perform surface analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

The course addresses undergraduate and graduate students interested in getting introduced into the basic concepts of biomineralization. The main goal of this course is to demonstrate the differences in communication between the fields of medicine and engineering. Since such differences become the most evident during actual collaborative work, the course is based on a current project in physiology research that combines medicine and engineering. For the engineering students, the specific aims of the course are to:

- Acquire a working understanding of the anatomy and physiology of the investigated system;
- Identify the engineering challenges in the project and communicate them to the medical students;
- Develop and implement, together with the medical students, solution strategies for the identified challenges;
- Present the found solutions to a cross-disciplinary audience.

After a general introduction to interdisciplinary communication and detailed background on the collaborative project, the engineering students will receive tailored lectures on the anatomy and physiology of the relevant system. They will then team up with medical students who have received a basic introduction to engineering methodology to collaborate on said project. In the process, they will be coached both by lecturers from ETH Zurich and the University of Zurich, receiving lectures customized to the project. The course will end with each team presenting their solution to a cross-disciplinary audience.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Prerequisites / notice

Supervised exercises solving real-world problems. Some Matlab based exercises in groups.

227-0965-00L Micro and Nano-Tomography of Biological Tissues

Abstract

The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

Objective

Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

Content

Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The course provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes

Available online

227-0981-00L Cross-Disciplinary Research and Development in Medicine and Engineering

Abstract

Cross-disciplinary collaboration between engineers and medical doctors is indispensable for innovation in health care. This course will bring together engineering students from ETH Zurich and medical students from the University of Zurich to experience the rewards and challenges of such interdisciplinary work in a project based learning environment.

Objective

The main goal of this course is to demonstrate the differences in communication between the fields of medicine and engineering. Since such differences become the most evident during actual collaborative work, the course is based on a current project in physiology research that combines medicine and engineering. For the engineering students, the specific aims of the course are to:

- Acquire a working understanding of the anatomy and physiology of the investigated system;
- Identify the engineering challenges in the project and communicate them to the medical students;
- Develop and implement, together with the medical students, solution strategies for the identified challenges;
- Present the found solutions to a cross-disciplinary audience.

Content

After a general introduction to interdisciplinary communication and detailed background on the collaborative project, the engineering students will receive tailored lectures on the anatomy and physiology of the relevant system. They will then team up with medical students who have received a basic introduction to engineering methodology to collaborate on said project. In the process, they will be coached both by lecturers from ETH Zurich and the University of Zurich, receiving lectures customized to the project. The course will end with each team presenting their solution to a cross-disciplinary audience.

Lecture notes

Handouts and relevant literature will be provided.

327-0505-00L Surfaces, Interfaces and their Applications I

Abstract

After being introduced to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most important techniques that can be used to characterize surfaces. Later, liquid interfaces are treated, followed by an introduction to the fields of tribology (friction, lubrication, and wear) and corrosion.

Objective

To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.

Content

Introduction to Surface Science

Physical Structure of Surfaces
Surface Forces (static and dynamic)
Adsorbates on Surfaces
Surface Thermodynamics and Kinetics
The Solid-Liquid Interface
Electron Spectroscopy
Vibrational Spectroscopy on Surfaces
Scanning Probe Microscopy
Introduction to Tribology
Introduction to Corrosion Science

Lecture notes

Script Download:

Literature

Script (20 CHF)

Prerequisites / notice

Chemistry:
General undergraduate chemistry
including basic chemical kinetics and thermodynamics

Physics:
General undergraduate physics
including basic theory of diffraction and basic knowledge of crystal structures

327-1101-00L Biomineralization

Abstract

The course addresses undergraduate and graduate students interested in getting introduced into the basic concepts of biomineralization. The course aims to introduce the basic concepts of biomineralization and the underlying principles, such as supersaturation, nucleation and growth of minerals, the interaction of biomolecules with mineral surfaces, and cell biology of inorganic materials creation. An important part of this class is the independent study and the presentation of original literature from the field.
Biomineralization is a multidisciplinary field. Topics dealing with biology, molecular and cell biology, solid state physics, mineralogy, crystallography, organic and physical chemistry, biochemistry, dentistry, oceanography, geology, etc. are addressed. The course covers definition and general concepts of biomineralization (BM)/ types of biominers and their function / crystal nucleation and growth / biological induction of BM / control of crystal morphology, habit, shape and orientation by organisms / strategies of compartmentalization / the interface between biomolecules (peptides, polysaccharides) and the mineral phase / modern experimental methods for studying BM phenomena / inter-, intra, extra- and epipelicular BM / organic templates and matrices for BM / structure of bone, teeth (vertebrates and invertebrates) and mollusk shells / calcification / siliification in diatoms, radiolarians and plants / calcium and iron storage / impact of BM on lithosphere and atmosphere/ evolution / taxonomy of organisms.

1. Introduction and overview
2. Biominerals and their functions
3. Chemical control of biomineralization
4. Control of morphology: Organic templates and additives
5. Modern methods of investigation of BM
6. BM in matrices: bone and nacre
7. Vertebrate teeth
8. Invertebrate teeth
9. BM within vesicles: calcite of coccoliths
10. Silica
11. Iron storage and mineralization.

Lecture notes
Script with more than 600 pages with many illustrations will be distributed free of charge.

Literature
3) P. M. Dove, J. J. DeYoreo, S. Weiner (Eds.) Biomineralization, Reviews in Mineralogy & Geochemistry Vol. 54, 2003

Prerequisites / notice
Each attendee is required to present a publication from the field. The selection of key papers is provided by the lecturer.

No special requirements are needed for attending. Basic knowledge in chemistry and cell biology is expected.

376-1622-00L Practical Methods in Tissue Engineering  W  5 credits  4P  K. Würtz-Kozak, M. Zenobi-Wong

Abstract
Number of participants limited to 12.

Objective
The goal of this course is to teach MSc students the necessary skills for doing research in the fields of tissue engineering and regenerative medicine.

Literature
S. Panke

A script will be provided.

402-0341-00L Medical Physics I  W  6 credits  2V+1U  P. Manser

Abstract
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

Objective
Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to teach that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.

Content
The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the exercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

Lecture notes
A script will be provided.

535-0423-00L Drug Delivery and Drug Targeting  W  2 credits  2V  J.C. Leroux, D. Brambilla

Abstract
The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand the field in terms of scientific criteria.

Objective
The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. The focus of the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and constraints of their therapeutic usage, with prime attention on anticancer drug, therapeutic peptides, proteins, nucleic acids and vaccines.

Content
The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

Lecture notes
Selected lecture notes, documents and supporting material will be directly provided or may be downloaded using
http://www.galenik.ethz.ch/teaching/drug_del_drug_targ

The website also displays additional information on peroral delivery systems, transdermal systems and systems for alternative routes (nasal, pulmonary) of delivery. These fields are covered in detail in the course Galenische Pharmazie II (Galenical Pharmacy II).

Literature

363-0507-00L Synthetic Biology II  W  4 credits  4A  S. Panke, Y. Benenison, J. Stelling

Abstract
7 months biological design project, during which the students are required to give presentations on advanced topics in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

Objective
The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

Content
Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence (DNA synthesis external), aiming to show the student analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Lecture notes
Handouts during course
Other Elective Courses

These courses may be suitable for the Molecular Bioengineering track. Please consult your track advisor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0313-00L</td>
<td>Microbiology (Part I)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>W.D. Hardt, L. Ebert, H.M. Fischer, J. Piel, M. Pilhofer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.</td>
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<tr>
<td>Objective</td>
<td>This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.</td>
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<tr>
<td>Content</td>
<td>Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.</td>
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<tr>
<td>Lecture notes</td>
<td>Updated handouts will be provided during the class.</td>
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<tr>
<td>Literature</td>
<td>Current literature references will be provided during the lectures.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The lecture &quot;Grundlagen der Biologie II: Mikrobiologie&quot; is the basis for this advanced lecture.</td>
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<tr>
<td>551-1103-00L</td>
<td>Microbial Biochemistry</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>J. Vorholt-Zambelli, J. Piel</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.</td>
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<tr>
<td>Objective</td>
<td>Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.</td>
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<tr>
<td>Content</td>
<td>List of topics:</td>
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<td>Eating sugars and letting them in</td>
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<td></td>
<td>Challenging: Aromatics, xenobiotics, and oil</td>
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<td></td>
<td>Complex: (Ligno-)Cellulose and in demand for bioenergy</td>
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<td></td>
<td>Living on a diet and the anaerobic provocation</td>
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<td>Of climate relevance: The microbial C1 cycle</td>
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<td>What are AMO and Anammox?</td>
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<td>20 amino acids: the making of</td>
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<td>Extending the genetic code</td>
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<td>The 21st and 22nd amino acid</td>
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<td>Some exotic biochemistry: nucleotides, cofactors</td>
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<td>Ancient biochemistry? Iron-sulfur clusters, polymers</td>
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<td>Secondary metabolites: playground of evolution</td>
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<tr>
<td>Lecture notes</td>
<td>A script will be provided during the course.</td>
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Biology Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0399-10L</td>
<td>Physiology and Anatomy for Biomedical Engineers I</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>H. Niemann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation,Computed Tomography and Magnetic Resonance imaging.</td>
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<tr>
<td>Objective</td>
<td>To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.</td>
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<tr>
<td>Content</td>
<td>- The Human Body: nomenclature, orientations, tissues</td>
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<td></td>
<td>- Musculokineskeletal system, Muscle contraction</td>
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<td>- Blood vessels, Heart, Circulation</td>
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<td></td>
<td>- Blood, Immune system</td>
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<td>- Respiratory system</td>
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<td></td>
<td>- Acid-Base-Homeostasis</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes and handouts.</td>
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<tr>
<td>Literature</td>
<td>Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thieme 2008</td>
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<td></td>
<td>Faller A., Schuenke M. The Human Body; Thieme 2004</td>
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<td></td>
<td>Nettter F. Atlas of human anatomy; Elsevier 2014</td>
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<tr>
<td>227-0945-00L</td>
<td>Cell and Molecular Biology for Engineers I</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>C. Frei</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is part I of a two-semester course. The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.</td>
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<tr>
<td>Objective</td>
<td>After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.</td>
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<tr>
<td>Content</td>
<td>Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.</td>
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<td>In addition, three journal clubs will be held, where one/two publications will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.</td>
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<tr>
<td>Lecture notes</td>
<td>Scripts of all lectures will be available.</td>
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<tr>
<td>227-0949-00L</td>
<td>Biological Methods for Engineers (Basic Lab)</td>
<td>W</td>
<td>2</td>
<td>4P</td>
<td>C. Frei</td>
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<tr>
<td>Limited number of participants.</td>
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</table>
The course during 4 afternoons (13h to 18h) covers basic laboratory skills and safety, cell culture, protein analysis, RNA/DNA isolation and RT-PCR. Each topic will be introduced, followed by practical work at the bench. Presence during the course is mandatory.

Objective
The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology.

Content
The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology.

Prerequisites / notice
Enrollment is limited and students from the Master's programme in Biomedical Engineering (BME) have priority.

<table>
<thead>
<tr>
<th>Semester Project</th>
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<tbody>
<tr>
<td><strong>Number</strong></td>
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<tr>
<td>227-1101-00L</td>
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<tr>
<td></td>
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<tr>
<td><strong>Abstract</strong></td>
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<tr>
<td><strong>Objective</strong></td>
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<tr>
<td><strong>Content</strong></td>
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<tr>
<td><strong>Literature</strong></td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
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<table>
<thead>
<tr>
<th>Master's Thesis</th>
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<tbody>
<tr>
<td><strong>Number</strong></td>
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<tr>
<td>227-1101-00L</td>
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<tr>
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<tr>
<td><strong>Abstract</strong></td>
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<tr>
<td><strong>Objective</strong></td>
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<td><strong>Content</strong></td>
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<tr>
<td><strong>Literature</strong></td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
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<tr>
<th>GESS Science in Perspective</th>
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<tbody>
<tr>
<td><strong>Number</strong></td>
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<tr>
<td>227-1700-00L</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
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<tr>
<td><strong>Objective</strong></td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
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<td><strong>Prerequisites / notice</strong></td>
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Note: Data: 06.11.2018 12:57 Autumn Semester 2016 Page 315 of 1571
### Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0970-00L</td>
<td>Research Topics in Biomedical Engineering</td>
<td>Z</td>
<td>0 credits</td>
<td>2K</td>
<td>M. Rudin, S. Kozerke, K. P. Prüssmann, M. Stampanoni, K. E. Stephan, J. Vörös</td>
</tr>
<tr>
<td>Abstract</td>
<td>Current topics in Biomedical Engineering presented by speakers from academia and industry.</td>
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<tr>
<td>Objective</td>
<td>Getting insight into actual areas and problems of Biomedical Engineering an Health Care.</td>
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<tr>
<td>227-0980-00L</td>
<td>Seminar on Biomedical Magnetic Resonance</td>
<td>Z</td>
<td>0 credits</td>
<td>2K</td>
<td>K. P. Prüssmann, S. Kozerke, M. Rudin</td>
</tr>
<tr>
<td>Abstract</td>
<td>Actual developments and problems of magnetic resonance imaging (MRI)</td>
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<tr>
<td>Objective</td>
<td>Getting insight to advanced topics in Magnetic Resonance Imaging</td>
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### Biomedical Engineering Master - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<td>K</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<td>R</td>
<td>revision course / private study</td>
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ECTS  European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Biotechnology Master

#### Majors

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<tr>
<th>Number</th>
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<tr>
<td>636-0001-00L</td>
<td>Separations in Biotechnology and Bioprocess</td>
<td>W+</td>
<td>6</td>
<td>3G</td>
<td>S. Panke</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a</td>
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<td></td>
<td>chemistry/biology background to select &amp; roughly design suitable separation processes for typical biotechnological products such as</td>
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<td>monoclonal antibodies, and fine chemicals and at providing a basic set of purification operations &amp; judge on process economy.</td>
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<td>Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process</td>
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<td>Introduction membrane operations adsorption and chromatography</td>
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<td>crystallization overall process economics</td>
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<td>6</td>
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<td>M. Fussenegger</td>
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<td><strong>Abstract</strong></td>
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<td></td>
<td>Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to</td>
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<td>engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main</td>
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<td>points in industrial decision-making to bring a therapeutic from target to market.</td>
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<tr>
<td></td>
<td>1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical</td>
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<td></td>
<td>Manufacturing.</td>
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<td>2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of</td>
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<td>Survival Pathways To Increase Robustness of Production Cell Lines.</td>
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<td>5. From Target To Market. An Antibody's Journey From Cell Culture to</td>
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<td>The Clinics.</td>
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<td>6. Biology and Malign Applications. Do Life Sciences Enable the</td>
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<td>Development of Biological Weapons?</td>
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<td>7. Functional Food. Enjoy Your Meal!</td>
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<td>6</td>
<td>3G</td>
<td>R. Paro, N. Beerenwinkel</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>This lecture course is an introduction to systems biology. It explores how complex biological networks are experimentally studied and how the</td>
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<td>resulting models is mathematically evaluated in order to derive predictive models. The biology of selected cellular processes, ranging from</td>
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<td>protein interaction networks to gene controlling systems and signaling cascades will be discussed in detail.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>The goal of this course is to learn how a detailed quantitative description of complex biological processes can be employed for a better</td>
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<td>understanding of molecular interactions, the power and efficiency of regulatory networks, and the evolution of biological complexity.</td>
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<td>Students will learn how to identify techniques producing quantitative data and how to develop mathematical models and efficient statistical</td>
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<td>inference algorithms to recognize patterns, molecular interrelationships and systems behavior.</td>
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<td><strong>Content</strong></td>
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<td>Sessions alternate between a thorough introduction into the basic biology of defined cellular processes and a corresponding</td>
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<td>mathematical and statistical analysis of the experimental data. Selected complex biological systems and the respective experimental tools for a</td>
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<td>quantitative analysis will be presented. Examples include the identification of protein interaction networks required for specific</td>
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<td>physiological processes in yeast based on graph theoretic methods, including the identification of network motifs and the global statistical</td>
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<td>analysis of graph properties (power laws); the comparative analysis of gene expressions data from cancer and normal cells involving data</td>
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<td>normalization techniques, multiple testing procedures, clustering algorithms, Bayesian networks, and linear dynamical systems; the</td>
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<td>definition of hierarchies of kinase signaling cascades employing Bayesian networks and their causal interpretation and nested effects models for</td>
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<td>the analysis of perturbed systems; analysis of deep sequencing data derived from studies of chromatin control and gene</td>
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<td>expression.</td>
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<td><strong>Topics:</strong></td>
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<td>- Control of Gene Expression: DNA binding proteins, gene activation in chromatin, posttranscriptional control</td>
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<td>- Genetic Switches: combinatorial gene control, transcriptional circuits, transcriptional noise/robustness</td>
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<td>- Analysis of Gene Expression Data: normalization, differential gene expression, multiple testing, PCA, clustering</td>
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<td>- Large-scale Genomic Profiling: mapping genomes/epigenomes, high throughput sequencing technologies</td>
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<td>- Analysis of Deep Sequencing Data: quality control, genome assembly, read mapping, RNA-seq, ChiP-seq</td>
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<td>- Biological Networks: signaling networks and protein-protein interaction networks</td>
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<td>- Network Biology: basic graph theory, motifs, dense subgraphs, power laws</td>
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<td>- Boolean Network Dynamics: Boolean algebra, Boolean networks, random Boolean networks, yeast cell cycle</td>
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<td>- Cellular Communication: signal transduction cascades, regulatory mechanisms.</td>
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<td>- Probabilistic Graphical Models: probabilities, statistical inference, Bayesian networks, nested effects models</td>
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<td>- Evolutionary Mechanisms: RNA world, origin of life, ribozyme selection, genome evolution, SNP mapping, evolution &amp; development</td>
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<td>- Genome-wide association studies</td>
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<td><strong>Lecture notes</strong></td>
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<td>The Powerpoint presentations of the lectures as well as other course material relevant for an active participation will be made available</td>
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<td>online.</td>
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<tr>
<td>636-0011-00L</td>
<td>Introduction to Biological Computers</td>
<td>W+</td>
<td>6</td>
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<td>Y. Benenson</td>
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<td><strong>Prerequisites:</strong> Synthetic Biology I (636-0002-00 L). Basic knowledge of molecular biology is assumed.</td>
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Data: 06.11.2018 12:57  Autumn Semester 2016  Page 317 of 1571
Abstract

Biological computers are man-made biological networks that interrogate and control biological hosts—cells and organisms—in which they operate. Their key features, inspired by computer science, are programmability, modularity and versatility. The course will show how to rationally design, implement and test biological computers using molecular engineering, DNA nanothechnology and synthetic biology.

Objective

The course has the following objectives:

* Familiarize students with parallels between theories in computer science and engineering and information-processing in live cells and organisms
* Introduce basic theories of computation
* Introduce approaches to creating novel biological computing systems in non-living environment and in living cells including bacteria, yeast and mammalian/human cells.

The covered approaches will include

- Nucleic acids engineering
- DNA and RNA nanotechnology
- Synthetic biology and gene circuit engineering
- High-throughput genome engineering and gene circuit assembly

* Equip the students with computer-aided design (CAD) tools for biocomputing circuit engineering. A number of tutorials will introduce MATLAB SimBiology toolbox for circuit design and simulations

* Foster creativity, research and communication skills through semester-long "Design challenge" assignment in the broad field of biological computing and biological circuit engineering.
Lecture 1. Introduction: what is molecular computation (part I)?

* What is computing in general?
* What is computing in the biological context (examples from development, chemotaxis and gene regulation)
* The difference between natural computing and engineered biocomputing systems

Lecture 2: What is molecular computation (part II) + State machines

1st hour

* Detailed definition of an engineered biocomputing system
* Basics of characterization
* Design challenge presentation

2nd hour

* Theories of computation: state machines (finite automata and Turing machines)

Lecture 3: Additional models of computation

* Logic circuits
* Analog circuits
* RAM machines

Basic approaches to computer science notions relevant to molecular computation. (i) State machines; (ii) Boolean networks; (iii) analog computing; (iv) distributed computing. Design Challenge presentation.

Lecture 4. Classical DNA computing

* Adleman experiment
* Maximal clique problem
* SAT problem

Lecture 5: Molecular State machines through self-assembly

* Tiling implementation of state machine
* DNA-based tiling system
* DNA/RNA origami as a spin-off of self-assembling state machines

Lecture 6: Molecular State machines that use DNA-encoded tapes

* Early theoretical work
* Tape extension system
* DNA and enzyme-based finite automata for diagnostic applications

Lecture 7: Introduction to cell-based logic and analog circuits

* Computing with (bio)chemical reaction networks
* Turing computation with ultrasensitivity and cooperativity
* Specific examples

Lecture 8: Transcriptional circuits I

* Introducing transcription-based circuits
* General features and considerations
* Guidelines for large circuit construction

Lecture 9: Transcriptional circuits II

* Large-scale distributed logic circuits in bacteria
* Toward large-scale circuits in mammalian cells

Lecture 10: RNA circuits I

* General principles of RNA-centered circuit design
* Riboswitches and sRNA regulation in bacteria
* Riboswitches in yeast and mammalian cells
* General approach to RNAi-based computing

Lecture 11: RNA circuits II

* RNAi logic circuits
* RNAi-based cell type classifiers
* Hybrid transcriptional/posttranscriptional approaches

Lecture 12: In vitro DNA-based logic circuits

* DNAzyme circuits playing tic-tac-toe against human opponents
* DNA brain

Lecture 13: Advanced topics

* Engineered cellular memory
* Counting and sequential logic
* The role of evolution
* Fail-safe design principles
We will use different diseases to discuss how to potentially model, diagnose or heal them by stem cell based therapies. This will be used as a guiding framework to discuss relevant concepts and technologies in cell and molecular biology, engineering, imaging, bioinformatics, tissue engineering, that are required to manipulate stem cells for therapeutic application.

Topics will include:
- Embryonic and adult stem cells and their niches
- Induced stem cells by directed reprogramming
- Relevant basic cell biology and developmental biology
- Relevant molecular biology
- Cell culture systems
- Cell fates and their molecular control by transcription factors and signalling pathways
- Cell reprogramming
- Disease modelling
- Tissue engineering
- Bioimaging, Bioinformatics
- Single cell technologies

---

**636-0013-00L Stem Cells: Biology and Therapeutic Manipulation**

**Abstract**
Stem cells are central in tissue regeneration and repair, and hold great potential for therapy. We will discuss the role of stem cells in health and disease, and possibilities to manipulate their behavior for therapeutic application. Basic molecular and cell biology, engineering and novel technologies relevant for stem cell research and therapy will be discussed.

**Objective**
Understanding of current knowledge, and lack thereof, in stem cell biology, regenerative medicine and required technologies. Theoretical preparation for practical laboratory experimentation with stem cells.

**Content**
We will use different diseases to discuss how to potentially model, diagnose or heal them by stem cell based therapies. This will be used as a guiding framework to discuss relevant concepts and technologies in cell and molecular biology, engineering, imaging, bioinformatics, tissue engineering, that are required to manipulate stem cells for therapeutic application.

**Prerequisites / notice**

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**636-0018-00L Data Mining I**

**Abstract**
Data Mining, the search for statistical dependencies in large databases, is of utmost important in modern society, in particular in biological and medical research. This course provides an introduction to the key problems, concepts, and algorithms in data mining, and the applications of data mining in computational biology.

**Objective**
The goal of this course is that the participants gain an understanding of data mining problems and algorithms to solve these problems, in particular in biological and medical applications.

**Content**
The goal of the field of data mining is to find patterns and statistical dependencies in large databases, to gain an understanding of the underlying system from which the data were obtained. In computational biology, data mining contributes to the analysis of vast experimental data generated by high-throughput technologies, and thereby enables the generation of new hypotheses.

In this course, we will present the algorithmic foundations of data mining and its applications in computational biology. The course will feature an introduction to popular data mining problems and algorithms, reaching from classification via clustering to feature selection. This course is intended for both students who are interested in applying data mining algorithms and students who would like to gain an understanding of the key algorithmic concepts in data mining.

**Tentative list of topics:**
1. Distance functions
2. Classification
3. Clustering
4. Feature Selection

**Lecture notes**
Course material will be provided in form of slides.

**Literature**
Will be provided during the course.

**Prerequisites**
Basic understanding of mathematics, as taught in basic mathematics courses at the Bachelor's level.

---

**636-0020-00L Microtechnology and Microelectronics**

**Abstract**
Students are introduced to the basics of semiconductors, microelectronics, microtechnology, and silicon process technology. They will get to know the fabrication of silicon-based microdevices and -systems by a sequence of defined batch processing steps as well as dedicated microfabrication processes.

**Objective**
Students are introduced to the basics of semiconductors, microelectronics, microtechnology, and silicon process technology. They will get to know the different fabrication methods for various microdevices and systems.

**Content**
Introduction to semiconductors, microelectronics, microtechnology, and micro electro mechanical systems (MEMS)

- Fundamentals of semiconductors
- Basics of microelectronics: transistor and diode.
- Silicon processing and fabrication steps
- Silicon crystal structure and manufacturing
- Thermal oxidation
- Doping via diffusion and ion implantation
- Photolithography
- Thin film deposition: dielectrics and metals
- Wet etching & bulk micromachining
- Dry etching & surface micromachining
- Microelectronics processing and fabrication sequence
- Packaging

**Lecture notes**
Handouts in English
**ELECTIVES**

The MSc Electives will be held in Zürich or Basel

<table>
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<tr>
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<td>Rate-Controlled Separations in Fine Chemistry</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Mazzotti</td>
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<tr>
<td>Abstract</td>
<td>The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.</td>
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<td>Objective</td>
<td>The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.</td>
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<tr>
<td>Content</td>
<td>The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.</td>
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<td>Handouts during the class</td>
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<td>Recommendations for text books will be covered in the class</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)</td>
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<td>363-0389-00L</td>
<td>Technology and Innovation Management</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Brusoni</td>
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<tr>
<td>Abstract</td>
<td>This course focuses on the analysis of innovation as a pervasive process that cut across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.</td>
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<tr>
<td>Objective</td>
<td>This course intends to enable all students to:</td>
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<td></td>
<td>- understand the core concepts necessary to analyze how innovation happens</td>
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<td></td>
<td>- master the most common methods and tools organizations deploy to innovate</td>
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<td></td>
<td>- develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation</td>
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<tr>
<td>Content</td>
<td>This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success are small. How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.</td>
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<tr>
<td>Lecture notes</td>
<td>Slides will be available on the TIMGROUP website.</td>
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<tr>
<td>Literature</td>
<td>Readings will be available on the TIMGROUP website.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>No specific background in economics or management is required</td>
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<tr>
<td>376-1714-00L</td>
<td>Biocompatible Materials</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>K. Maniera, J. Möller, M. Zenobi-Wong</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.</td>
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<tr>
<td>Objective</td>
<td>The class consists of three parts:</td>
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<tr>
<td></td>
<td>1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.</td>
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<td></td>
<td>2. The concept of biocompatibility.</td>
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<td>3. Introduction into methodology used in biomaterials research and application.</td>
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<tr>
<td>Content</td>
<td>Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed. In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts can be accessed online.</td>
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<tr>
<td>Literature</td>
<td>Literature</td>
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<td></td>
<td>(available online via ETH library)</td>
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<td></td>
<td>Handouts provided during the classes and references therin.</td>
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<tr>
<td>529-0723-00L</td>
<td>Enzymes</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>D. Hilvert</td>
</tr>
<tr>
<td>Abstract</td>
<td>Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.</td>
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</table>

A script will not be handed out. General:

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

529-0837-00L Biomicrofluidic Engineering W+ 7 credits 3G A. de Mello

Microfluidics describes the behaviour, control and manipulation of fluids that are geometrically constrained within sub-microlitre environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale.

The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.

Specific topics in the course include, but not limited to:

1. Theoretical Concepts
Features of mass and thermal transport on the microscale
Key scaling laws

2. Microfluidic Device Manufacture
Conventional lithographic processing of rigid materials
Soft lithographic processing of plastics and polymers
Mass fabrication of polymeric devices

3. Unit operations and functional components
Analytical separations (electrophoresis and chromatography)
Chemical and biological synthesis
Sample pre-treatment (filtration, SPE, pre-concentration)
Molecular detection

4. Design Workshop
Design of microfluidic architectures for PCR, distillation & mixing

5. Contemporary Applications in Biological Analysis
Microarrays
Cellular analyses (single cells, enzymatic assays, cell sorting)
Proteomics

6. System integration
Applications in radiochemistry, diagnostics and high-throughput experimentation

Lecture notes
Lecture handouts, background literature, problem sheets and notes will be provided electronically.

535-0030-00L Therapeutic Proteins W 3 credits 3G C. Halin Winter, D. Neri

In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed. Furthermore, students will expand their training in pharmaceutical immunology and will be introduced to the basic concepts of pharmaceutical product quality management.

In a first part, students will complete their training of pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenic mechanisms of immune-mediated diseases. Deepened knowledge of immunology will be relevant for understanding the mechanism of action of many therapeutic proteins, as well as for understanding one major concern related to the use of protein-based drugs, namely, immunogenicity.

The second part focuses on topics related to the development and application of therapeutic proteins, such as protein expression, protein engineering, reducing immunogenicity, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.

Lecture notes
Handouts to the lectures will be available for downloading under http://www.pharma.ethz.ch/scripts/index

Literature
- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

535-0423-00L Drug Delivery and Drug Targeting W 2 credits 2V J.C. Leroux, D. Brambilla

The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand and evaluate the field in terms of scientific criteria.

The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. The focus of the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and constraints of their therapeutic usage, with prime attention on anticancer drugs, therapeutic peptides, proteins, nucleic acids and vaccines.

The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

Selected lecture notes, documents and supporting material will be directly provided or may be downloaded using http://www.galenik.ethz.ch/teaching/drug_del_drug_targ

The website also displays additional information on peroral delivery systems, transdermal systems and systems for alternative routes (nasal, pulmonary) of delivery. These fields are covered in detail in the course Galenische Pharmazie II (Galenical Pharmacy II).
The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease

An Introduction to Probability Theory and Stochastic Processes with Applications to Biology

Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:

- stochastic models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics
- epidemiology
- pathogen evolution
- macroevolution of species

The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze the output (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.
Lecture notes
Slides of the lecture will be available online.
https://www.bsse.ethz.ch/cevo/education/cb-materials.html

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

636-0501-00L Advanced Immunology
W 2 credits 2V external organisers

636-0503-00L Advanced Molecular Parasitology
W 2 credits 2V external organisers

636-0507-00L Synthetic Biology
W+ 4 credits 4A S. Panke, Y. Benenson, J. Stelling

Abstract
7 months biological design project, during which the students are required to give presentations on advanced topics in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

Objective
The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, thorough analysis, and the subsequent experimental implementation of the system and the related problems.

Content
Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external,) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Lecture notes
Handouts during course

Prerequisites / notice
The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

636-0508-00L Genomics in Drug Discovery Research
W 2 credits 2V external organisers

636-0511-00L Developmental Neuroscience (HS)
W 2 credits 2V external organisers

636-0515-00L Molecular Medicine I
W 2 credits 2V external organisers

636-0706-00L Spatio-Temporal Modelling in Biology
W 5 credits 3G D. Iber

Abstract
This course focuses on modeling spatio-temporal problems in biology, in particular on the cell and tissue level. A wide range of mathematical techniques will be presented as part of the course, including concepts from non-linear dynamics (ODE and PDE models), stochastic techniques (SDE, Master equations, Monte Carlo simulations), and thermodynamic descriptions.

Objective
The aim of the course is to introduce students to state-of-the-art mathematical modelling of spatio-temporal problems in biology. Students will learn how to chose from a wide range of modelling techniques and how to apply these to further our understanding of biological mechanisms. The course aims at equipping students with the tools and concepts to conduct successful research in this area; both classical as well as recent research work will be discussed.

Content
1. Introduction to Modelling in Biology
2. Morphogen Gradients
3. Turing Pattern
4. Travelling Waves & Wave Pinning
5. Application Example 1: Dorso-ventral axis formation
6. Chemotaxis, Cell Adhesion & Migration
7. Introduction to Numerical Methods
8. Simulations on Growing Domains
9. Image-Based Modelling
10. Branching Processes
11. Cell-based Simulation Frameworks
12. Application Example 2: Limb Development
13. Summary

Lecture notes
All lecture material will be made available online
https://www.bsse.ethz.ch/cobi/education/636-0706-00L_Spatial_Modelling_in_Biology.html

Prerequisites / notice
The course builds on introductory courses in Computational Biology. The course assumes no background in biology but a good foundation regarding mathematical and computational techniques.

752-4005-00L Food Microbiology I
W 3 credits 2V M. Loessner

Abstract
For students of the study programme Biology BSc the course can only be selected as 4th concept course.

Objective
This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.
Content

1. History of Food Microbiology
   1.1. Short synopsis of foodborne microorganisms
   1.2. Spoilage of Foods
   1.3. Foodborne Disease
   1.4. Food Preservation
   1.5. VIP’s of Food Microbiology
2. Overview of Microorganisms in Foods
   2.1. Origin of foodborne Microorganisms
   2.2. Bacteria
   2.3. Yeasts
   2.4. Molds
   3. Microbial Spoilage of Foods
   3.1. Intrinsic and Extrinsic Parameters
   3.2. Meats, Seafoods, Eggs
   3.3. Milk and Milk Products
   3.4. Vegetable and Fruit Products
   3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   3.6. Drinks and Canned Foods
4. Foodborne Disease
   4.1. Significance and Transmission of Foodborne pathogens
   4.2. Staphylococcus aureus
   4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4.4. Listeria monocytogenes
   4.5. Salmonella, Shigella, Escherichia coli
   4.6. Vibrio, Yersinia, Campylobacter
   4.7. Brucella, Mycobacterium
   4.8. Parasites
   4.9. Viruses and Bacteriophages
   4.10. Mycotoxins
   4.11. Bioactive Amines
   4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

Lecture notes
Electronic copies of the presentation slides (PDF) and additional material will be made available for download.

Literature
Recommendations will be given in the first lecture

636-0021-00L Mathematical Modelling in Systems Biology
W+ 5 credits 3G D. Iber

Abstract
Basic concepts and mathematical tools to explore biochemical reaction kinetics and biological network dynamics.

Objective
The aim of the course is to provide an introductory overview of mathematical and computational methods to analyse biological network dynamics.

Content
1. Introduction to Mathematical Modeling
2. Introduction to Biochemical Reaction Modeling
3. Model Analysis: Phase Plane
4. Model Analysis: Linear Stability Analysis
5. Model Analysis: Bifurcation Analysis
6. Regulatory Feedback: Switches
7. Regulatory Feedback: Adaptation
8. Regulatory Feedback: Oscillations and Delay Equations
9. Receptor Signaling and Signaling Cascades
10. Network Properties: Sensitivity and Robustness
11. Introduction to Parameter Estimation

Lecture notes

Literature
- Keener and Sneyd, Mathematical Physiology, Springer
- Klipp et al, Systems Biology in Practice, Wiley
- Kreyszig, Engineering Mathematics, Wiley

Prerequisites / notice
Introductory courses in Mathematics (Linear Algebra, Differential Equations, Numerics) and basic concepts of programming.

Research Project
In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective
Students get acquainted with scientific working methods and deepen their knowledge in a particular research area.

Master’s Thesis
Only students who fulfill the following criteria are allowed to begin with their master thesis:

- successful completion of the bachelor programme
- successful completion of any additional requirements necessary to gain admission to the master programme.

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is carried out under the supervision of a professor in a research group of the D-BSSE, usually at the D-BSSE. Students are free to choose the area.

Objective
In the Master Thesis students prove their ability to independent, structured and scientific working.

GESS Science in Perspective
Recommended GESS Science in Perspective (Type B) for D-BSSE.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses
ETH/UZH
Seminars, Colloquia and Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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</table>

Abstract
This seminar will feature invited lectures about recent advances and developments in systems biology, including topics from biology, bioengineering, and computational biology.

Objective
To provide an overview of current systems biology research.

Content
The final list of topics will be available at http://www.bsse.ethz.ch/education/.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>626-0002-AAL</td>
<td>Bioinformatics</td>
<td>E-</td>
<td>4 credits</td>
<td>9R</td>
<td>J. Stelling, N. Beerenwinkel</td>
</tr>
</tbody>
</table>

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
The course introduces concepts of bioinformatics starting from first principles: DNA sequence alignment, phylogenetic tree inference, genome annotation, protein structure and function prediction. Key methods and algorithms are covered, including dynamic programming, Markov and Hidden Markov models, and molecular dynamics simulations. Practical applications and limitations are discussed.

Objective
The course aims at introducing the fundamental concepts and methods of bioinformatics. Emphasis is given to a deep understanding of the methods' foundations and limitations to enable critical evaluations and applications of bioinformatics tools in areas such as biotechnology and systems biology.

Content
From "Understanding Bioinformatics":
Chapter 4: Producing and Analyzing Sequence Alignments
Chapter 5: Pairwise Sequence Alignment and Database Searching
Chapter 6: Patterns, Profiles, and Multiple Alignments
Chapter 7: Recovering Evolutionary History
Chapter 8: Building Phylogenetic Trees
Chapter 9: Revealing Genome Features
Chapter 10: Gene Detection and Genome Annotation
Chapter 11: Obtaining Secondary Structure from Sequence
Chapter 12: Predicting Secondary Structures
Chapter 13: Modeling Protein Structure
Chapter 14: Analyzing Structure-Function Relationships
From "Biological Sequence Analysis":
Sections 3.1, 3.2, 3.3, 4.1, 4.2, 4.4, 5.2, 5.3, 5.4, 6.5 (Markov Chains and Hidden Markov Models)
From "A First Course in Systems Biology":
Chapter 1: Biological Systems

Lecture notes
Course material will be made available at: http://www.csb.ethz.ch

Literature

Prerequisites / notice
There will be two opportunities for tutorials during the semester
http://www.csb.ethz.ch/teaching

626-0003-AAL Molecular Biology E- 4 credits 9R R. Paro

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
This lecture course gives an in-depth view into molecular mechanisms controlling basic biological processes, ranging from genetic regulatory networks, the internal functional organization of a cell to the signaling events controlling cells in their social context. An additional focus is on methods and techniques used in molecular biology to solve problems in biotechnology and medicine.

Objective
The goal is to achieve a high level knowledge of basic biological processes, to learn the methodology to tackle questions in molecular biology and to interpret experimental molecular data. Emphasis is given to cellular processes amenable to studies in systems and synthetic biology.

Chapter 4 DNA, Chromosomes, and Genomes  
Chapter 5 DNA Replication, Repair, and Recombination  
Chapter 6 How Cells Read the Genome: From DNA to Protein  
Chapter 7 Control of Gene Expression  
Chapter 8 Analyzing Cells, Molecules, and Systems  
Chapter 9 Visualizing Cells  
Chapter 10 Membrane Structure  
Chapter 11 Membrane Transport of Small Molecules and the Electrical Properties of Membranes  
Chapter 12 Intracellular Compartments and Protein Sorting  
Chapter 13 Intracellular Membrane Traffic  
Chapter 15 Cell Signaling  
Chapter 16 The Cell Cycle  
Chapter 17 The Cell Cycle  
Chapter 18 Cell Death  
Chapter 20 Cancer  
Chapter 22 Stem Cells and Tissue Renewal

Lecture notes
Use the respective end-of-chapter problems section (“Which statements are true?”) to test your knowledge and prepare for exam.

Literature
http://www.garlandscience.com/product/isbn/9780815344322

Book Summary
As the amount of information in biology expands dramatically, it becomes increasingly important for textbooks to distill the vast amount of scientific knowledge into concise principles and enduring concepts. As with previous editions, Molecular Biology of the Cell, Sixth Edition accomplishes this goal with clear writing and beautiful illustrations. The Sixth Edition has been extensively revised and updated with the latest research in the field of cell biology, and it provides an exceptional framework for teaching and learning.

The entire illustration program has been greatly enhanced. Protein structures better illustrate structure-function relationships, icons are simpler and more consistent within and between chapters, and micrographs have been refreshed and updated with newer, clearer, or better images. As a new feature, each chapter now contains intriguing open-ended questions highlighting “What We Don’t Know” introducing students to challenging areas of future research. Updated end-of-chapter problems reflect new research discussed in the text, and these problems have been expanded to all chapters by adding questions on developmental biology, tissues and stem cells, pathogens, and the immune system.

Prerequisites / notice
During the semester two half days will be offered to discuss the content and allow questions to the lecturer.

626-0007-AAL  
Microbial Biotechnology
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction into the field of microbial biotechnology, covering possible products of enzyme and fermentation technology.

Objective
The student should be able to identify opportunities for microbial bioprocesses and to go through basic and advanced design procedures for microbial bioprocesses.

Content
Bioprocess development - An interdisciplinary challenge
Introduction to engineering calculations
Presentation and analysis of data
Material balances
Energy balances
Unsteady-state material and energy balances
Fluid flow
Mixing
Mass transfer
Homogeneous reactions
Heterogeneous reactions
Reactor engineering
Literature
Pauline Doran, Bioprocess Engineering Principles, edition 2013, chapters 1 to 8, 10, 12-14

Other literature:
Nielsen/Villadsen, Bioreaction Engineering Principles (Kluwer)
vant Riet/Tramper: Basic bioreactor design
Stephanopoulos/Aristidou/Nielsen: Metabolic Engineering

Prerequisites / notice
There will be two opportunities for tutorials during the semester.

### Biotechnology Master - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

### ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The main goal of this course is to convey a deep understanding of the key concepts of sequential object-oriented programming and their support through various language features. Students should be able to understand language concepts on a semantic level and be able to compare and evaluate language designs. The pitfalls of object initialization, exemplified by a research type system that prevents null pointer dereferencing, should be avoided.

Content

The main goal of this course is to convey a deep understanding of the key concepts of sequential object-oriented programming and their support through various language features. This is achieved by studying how important challenges are addressed through language features and programming idioms. In particular, the course discusses alternative language designs by contrasting solutions in languages such as C++, C#, Eiffel, Java, Python, and Scala. The course also introduces novel ideas from research languages that may influence the design of future mainstream languages.

The topics discussed in the course include among others:
- The pros and cons of different flavors of type systems (for instance, static vs. dynamic typing, nominal vs. structural, syntactic vs. behavioral typing)
- The key problems of single and multiple inheritance and how different languages address them
- Generic type systems, in particular, Java generics, C# generics, and C++ templates
- The situations in which object-oriented programming does not provide encapsulation, and how to avoid them
- How to maintain the consistency of data structures

Literature

Will be announced in the lecture.

Prerequisites / notice

Prerequisites:
- Mastering at least one object-oriented programming language (this course will NOT provide an introduction to object-oriented programming); programming experience

Certificate of Advanced Studies in Computer Science

Focus Courses and Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0237-00L</td>
<td>Concepts of Object-Oriented Programming</td>
<td>W</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>P. Müller</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Course that focuses on an in-depth understanding of object-oriented programming and compares designs of object-oriented programming languages. Topics include different flavors of type systems, inheritance models, encapsulation in the presence of aliasing, object and class initialization, program correctness, reflection.</td>
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<td>Objective</td>
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<td>After this course, students will:</td>
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<td>Have a deep understanding of advanced concepts of object-oriented programming and their support through various language features. Be able to understand language concepts on a semantic level and be able to compare and evaluate language designs. Be able to learn new languages more rapidly. Be aware of many subtle problems of object-oriented programming and know how to avoid them.</td>
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<td>Content</td>
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<td>The main goal of this course is to convey a deep understanding of the key concepts of sequential object-oriented programming and their support in different programming languages. This is achieved by studying how important challenges are addressed through language features and programming idioms. In particular, the course discusses alternative language designs by contrasting solutions in languages such as C++, C#, Eiffel, Java, Python, and Scala. The course also introduces novel ideas from research languages that may influence the design of future mainstream languages.</td>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0286-00L</td>
<td>System Construction</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>F. O. Friedrich</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>Main goal is teaching knowledge and skills needed for building custom operating systems and runtime environments. Relevant topics are studied at the example of sufficiently simple systems that have been built at our Institute in the past, ranging from purpose-oriented single processor real-time systems up to generic system kernels on multi-core hardware.</td>
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<td></td>
<td>Objective</td>
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<td>The lecture's main goal is teaching of knowledge and skills needed for building custom operating systems and runtime environments. The lecture intends to supplement more abstract views of software construction, and to contribute to a better understanding of &quot;how it really works&quot; behind the scenes.</td>
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<td>Content</td>
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<tr>
<td></td>
<td>Case Study 1: Embedded System</td>
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<td></td>
<td>- Safety-critical and fault-tolerant monitoring system</td>
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<td>- Based on an auto-pilot system for helicopters</td>
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<td>Case Study 2: Multi-Processor Operating System</td>
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<td>- Universal operating system for symmetric multiprocessors</td>
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<td></td>
<td>- Shared memory approach</td>
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<td></td>
<td>- Based on Language-/System Codegen (Active Oberon / A2)</td>
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<td>Case Study 3: Custom designed Single-Processor System</td>
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<td>- RISC Single-processor system designed from scratch</td>
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<td>- Hardware on FPGA</td>
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<td>- Graphical workstation OS and compiler (Project Oberon)</td>
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<td>Case Study 4: Custom-designed Multi-Processor System</td>
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<td>- Special purpose heterogeneous system on a chip</td>
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<td>- Massively parallel hard- and software architecture based on message passing</td>
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<td></td>
<td>- Focus: dataflow based applications</td>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>252-0293-00L</td>
<td>Wireless and Mobile Computing for Entertainment Applications</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>S. Mangold</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>This course gives a detailed overview about the 802 standards and summarizes the state of the art for WLANs, WPANs, and WMANs, including new features such as mesh networks, cognitive radio, and visible light communications. The course combines lectures with a set of assignments in which students are asked to work with a simple JAVA simulation software.</td>
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<td>The objective of the course is to learn about the general principles of wireless communications, including physics, frequency spectrum regulation, and standards. Further, the most up-to-date standards and protocols used for wireless LAN IEEE 802.11, Bluetooth and Wi-Fi, mesh networks, sensor networks, cellular networks, visible light communication, and cognitive radios, are analyzed and evaluated. Students develop their own add-on mobile computing algorithms to improve the behavior of the systems, using a Java-based event-driven simulator. We also hand out embedded systems that can be used for experiments for optical communication.</td>
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<td>Content</td>
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<tr>
<td>252-0341-01L</td>
<td>Information Retrieval</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>T. Hofmann</td>
</tr>
</tbody>
</table>
Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation.

In depth understanding of managing, indexing, and retrieving documents with text, image and XML content. Knowledge about basic search algorithms on the web, benchmarking of search algorithms, and relevance feedback methods.

The course examines how traditional information system architectures and technologies have been adapted to support various forms of mobile and personal information systems. Topics to be covered include databases of mobile objects; context-aware services; opportunistic information sharing; ambient information; pervasive display systems.

Students will be introduced to a variety of novel information services and architectures developed for mobile environments in order to gain insight into the requirements and processes involved in designing and developing such systems and learning to think beyond traditional information systems.

Advances in mobile devices and communication technologies have led to a rapid increase in demands for various forms of mobile information systems where the users, the applications and the databases themselves may be mobile. Based on both lectures and breakout sessions, this course examines the impact of the different forms of mobility and collaboration that systems require nowadays and how these influence the design of systems at the database, the application and the user interface level. For example, traditional data management techniques have to be adapted to meet the requirements of such systems and cope with new connection, access and synchronisation issues. As mobile devices have increasingly become integrated into the users' lives and are expected to support a range of activities in different environments, applications should be context-aware, adapting functionality, information delivery and the user interfaces to current environment and task. Various forms of software and hardware sensors may be used to determine the current context, raising interesting issues for discussion. Finally, user mobility, and the varying and intermittent connectivity that it implies, gives rise to new forms of dynamic collaboration that require lightweight, but flexible, mechanisms for information synchronisation and consistency maintenance. Here, the interplay of mobile, personal and social context will receive special attention.

The course examines how traditional information system architectures and technologies have been adapted to support various forms of mobile and personal information systems. The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied to solve typical problems in these areas.

Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Abstract

Mobile and Personal Information Systems

Objective

In depth understanding of managing, indexing, and retrieving documents with text, image and XML content. Knowledge about basic search algorithms on the web, benchmarking of search algorithms, and relevance feedback methods.

252-0373-00L

Mobile and Personal Information Systems

W

4 credits

2V+1U

M. Norrie

Abstract

The course examines how traditional information system architectures and technologies have been adapted to support various forms of mobile and personal information systems. Topics to be covered include databases of mobile objects; context-aware services; opportunistic information sharing; ambient information; pervasive display systems.

Objective

Students will be introduced to a variety of novel information services and architectures developed for mobile environments in order to gain insight into the requirements and processes involved in designing and developing such systems and learning to think beyond traditional information systems.

Content

Advances in mobile devices and communication technologies have led to a rapid increase in demands for various forms of mobile information systems where the users, the applications and the databases themselves may be mobile. Based on both lectures and breakout sessions, this course examines the impact of the different forms of mobility and collaboration that systems require nowadays and how these influence the design of systems at the database, the application and the user interface level. For example, traditional data management techniques have to be adapted to meet the requirements of such systems and cope with new connection, access and synchronisation issues. As mobile devices have increasingly become integrated into the users' lives and are expected to support a range of activities in different environments, applications should be context-aware, adapting functionality, information delivery and the user interfaces to current environment and task. Various forms of software and hardware sensors may be used to determine the current context, raising interesting issues for discussion. Finally, user mobility, and the varying and intermittent connectivity that it implies, gives rise to new forms of dynamic collaboration that require lightweight, but flexible, mechanisms for information synchronisation and consistency maintenance. Here, the interplay of mobile, personal and social context will receive special attention.

Randomized Algorithms and Probabilistic Methods

W

7 credits

3V+2U+1A

A. Steger, E. Welzl

Abstract

Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks.

Objective

After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Content

Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Lecture notes

Yes.

Literature


Distributed Algorithms

W

4 credits

3V

F. Mattern

Abstract

Models of distributed computations, time space diagrams, virtual time, logical clocks and causality, wave algorithms, parallel and distributed graph traversal, consistent snapshots, mutual exclusion, election and symmetry breaking, distributed termination detection, garbage collection in distributed systems, monitoring distributed systems, global predicates.

Objective

Become acquainted with models and algorithms for distributed systems.

Content

Verteilte Algorithmen sind Verfahren, die dadurch charakterisiert sind, dass mehrere autonom e Prozesse gleichzeitig Teile eines gemeinsamen Problems in kooperativer Weise bearbeiten und der dabei erforderliche Informationsaustausch ausschliesslich über Nachrichten erfolgt. Derartige Algorithmen kommen im Rahmen verteilter Systeme zum Einsatz, bei denen kein gemeinsamer Speicher existiert und die Übertragungszeit von Nachrichten i.a. nicht vernachlässigt werden kann. Da dabei kein Prozess eine aktuelle konsistente Sicht des globalen Zustands besitzt, führt dies zu interessanten Problemen. Im einzelnen werden u.a. folgende Themen behandelt:

- Modelle verteilter Berechnungen; Raum-Zeit Diagramme; Virtuelle Zeit; Logische Uhren und Kausalität; Weilenalgorithmen; Verteilte und parallele Graphtraversierung; Berechnung konsistenter Schnappschüsse; Wechselseitiger Ausschluss; Elektion und Symmetriebruch; Verteilte Terminierung; Garbage-Collection in verteilten Systemen; Beobachten verteilter Systeme; Berechnung globaler Prädikate.

- F. Mattern: Verteilte Basialgorithmen, Springer-Verlag
- G. Tel: Topics in Distributed Algorithms, Cambridge University Press
- G. Tel: Introduction to Distributed Algorithms, Cambridge University Press, 2nd edition
- N. Lynch: Distributed Algorithms, Morgan Kaufmann Publ

Security Engineering

W

5 credits

2V+2U

D. Basin

Abstract

Subject of the class are engineering techniques for developing secure systems. We examine concepts, methods and tools, applied within the different activities of the SW development process to improve security of the system. Topics: security requirements & risk analysis, system modeling & model-based development methods, implementation-level security, and evaluation criteria for secure systems.

Objective

Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.

Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include

* security requirements & risk analysis,
* system modeling and model-based development methods,
* implementation-level security, and
* evaluation criteria for the development of secure systems.
Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.

Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include

* security requirements & risk analysis,
* system modeling and model-based development methods,
* implementation-level security, and
* evaluation criteria for the development of secure systems

Modules taught:

1. Introduction
   - Introduction of Infsec group and speakers
   - Security meets SW engineering: an introduction
   - The activities of SW engineering, and where security fits in
   - Overview of this class
2. Requirements Engineering: Security Requirements and some Analysis
   - overview: functional and non-functional requirements
   - use cases, misuse cases, sequence diagrams
   - safety and security
   - FMEA, FTA, attack trees
3. Modeling in the design activities
   - structure, behavior, and data flow
   - class diagrams, statecharts
4. Model-driven security for access control (design)
   - SecureUML as a language for access control
   - Combining Design Modeling Languages with SecureUML
   - Semantics, i.e., what does it all mean,
   - Generation
   - Examples and experience
5. Model-driven security (Part II)
   - Continuation of above topics
6. Security patterns (design and implementation)
7. Implementation-level security
   - Buffer overflows
   - Input checking
   - Injection attacks
8. Testing
   - overview
   - model-based testing
   - testing security properties
9. Risk analysis and management 1 (project management)
   - "risk": assets, threats, vulnerabilities, risk
   - risk assessment: quantitative and qualitative
   - safeguards
   - generic risk analysis procedure
   - The OCTAVE approach
10. Risk analysis: IT baseline protection
    - Overview
    - Example
11. Evaluation criteria
    - CMM
    - systems security engineering CMM
    - common criteria
12. Guest lecture
    - TBA

Literature
- Further relevant books and journal/conference articles will be announced in the lecture.

Prerequisites / notice
Prerequisite: Class on Information Security
This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods.

Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and understanding how to model and analyze strategic interactions are the primary objectives of this course. The course will cover topics such as game theory, mechanism design, and algorithmic game theory, with a focus on recent algorithmic and mathematical developments.

Abstract:
This course covers the fundamentals of computer graphics, specifically 3D object representations and generation of photorealistic images from digital representations of 3D scenes.

Objective:
At the end of the course, students will be able to build a rendering system and understand basic concepts of rendering and image synthesis. In addition, the course aims to stimulate students' curiosity to explore the field of computer graphics in subsequent courses or on their own.

Literature:

Prerequisites:
Fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, and programming skills in C++ are required. The course requires solid basic knowledge in analysis, statistics, and numerical methods for CSE as well as practical programming experience for solving assignments.

Prerequisites / notice:
The course requires solid basic knowledge in analysis, statistics, and numerical methods for CSE as well as practical programming experience for solving assignments. Students should have completed a previous course on game theory or mechanism design, or have equivalent knowledge from another institution.

Prerequisites:
- 252-0543-01L Computer Graphics
- 252-0546-00L Physically-Based Simulation in Computer Graphics
- 252-1407-00L Algorithmic Game Theory

252-0543-01L Computer Graphics
- Topics covered in the course include:
  - Bayesian theory of optimal decisions
  - Maximum likelihood and Bayesian parameter inference
  - Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
  - Ensemble methods: Bagging and Boosting
  - Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
  - Non-parametric density estimation: Parzen windows, nearest neighbour
  - Dimension reduction: principal component analysis (PCA) and beyond

252-0546-00L Physically-Based Simulation in Computer Graphics
- This course provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.

252-1407-00L Algorithmic Game Theory
- Topics covered in the course include:
  - Introduction to classic game-theoretic concepts.
  - Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
  - Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization.
  - Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the 'Price of Anarchy').
  - Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium.
  - Selected current research topics, such as Google's Sponsored Search Auction, the U.S. FCC Spectrum Auction, Kidney Exchange.

Lecture notes:
No lecture notes, but slides will be made available on the course webpage.
Abstract

The first part of the lecture covers individual system aspects starting with tamperproof or tamper-resistant hardware in general over operating system related security mechanisms to application software systems, such as host based intrusion detection systems. In the second part, the focus is on system design and methodologies for building secure systems.

In this lecture, students learn about the security requirements and capabilities that are expected from modern hardware, operating systems, and other software environments. An overview of available technologies, algorithms and standards is given, with which these requirements can be met.

The first part of the lecture covers individual system’s aspects starting with tamperproof or tamper-resistant hardware in general over operating system related security mechanisms to application software systems such as host based intrusion detection systems. The main topics covered are: tamper resistant hardware, CPU support for security, protection mechanisms in the kernel, file system security (permissions / ACLs / network filesystem issues), IPC Security, mechanisms in more modern OS, such as Capabilities and Zones, Libraries and Software tools for security assurance, etc.

In the second part, the focus is on system design and methodologies for building secure systems. Topics include: patch management, common software faults (buffer overflows, etc.), writing secure software (design, architecture, QA, testing), compiler-supported security, language-supported security, logging and auditing (BSM audit, dtrace, ...), cryptographic support, and trustworthy computing (TCG, SGX).

Along the lectures, model cases will be elaborated and evaluated in the exercises.

Objective

The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains.

Prerequisites / notice

Several copies of both books are available in the Computer Science library.

Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

Literature


Prerequisites / notice

Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH. Outlook: In the following spring semester there is a seminar "Geometry: Combinatorics and Algorithms" that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.

252-1414-00L System Security

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>2V+2U+1A</td>
<td>After this course, the students should be able to: describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc/sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.</td>
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<tr>
<td>2V+2U</td>
<td>After this course, the students should be able to: describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc/sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.</td>
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<tr>
<td>1A</td>
<td>After this course, the students should be able to: describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc/sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.</td>
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252-1411-00L Security of Wireless Networks

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<th>Credit Hours</th>
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<tbody>
<tr>
<td>5</td>
<td>Core Elements: Wireless communication channel, Wireless network architectures and protocols, Attacks on wireless networks, Protection techniques</td>
<td>Core Elements: Wireless communication channel, Wireless network architectures and protocols, Attacks on wireless networks, Protection techniques</td>
</tr>
<tr>
<td>2V+1U+1A</td>
<td>After this course, the students should be able to: describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc/sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.</td>
<td>Wireless channel basics. Wireless electronic warfare: jamming and target tracking. Basic security protocols in cellular, WLAN and multi-hop networks. Recent advances in security of multi-hop networks; RFID privacy challenges and solutions.</td>
</tr>
<tr>
<td>2V+2U+1A</td>
<td>After this course, the students should be able to: describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc/sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.</td>
<td>Wireless channel basics. Wireless electronic warfare: jamming and target tracking. Basic security protocols in cellular, WLAN and multi-hop networks. Recent advances in security of multi-hop networks; RFID privacy challenges and solutions.</td>
</tr>
<tr>
<td>1A</td>
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</tr>
</tbody>
</table>
This combination of requirements, together with the technologies that have emerged in order to address them, is typically referred to as "Big Data." This revolution has led to a completely new way to do business, e.g., develop new products and business models, but also to do science -- which is sometimes referred to as data-driven science or the "fourth paradigm".

Unfortunately, the quantity of data produced and available -- now in the Zettabyte range (that's 21 zeros) per year -- keeps growing faster than our ability to process it. Hence, new architectures and approaches for processing it were and are still needed. Harnessing them must involve a deep understanding of data not only in the large, but also in the small.

The field of databases evolves at a fast pace. In order to be prepared, to the extent possible, to the (re)volutions that will take place in the next few decades, the emphasis of the lecture will be on the paradigms and core design ideas, while today's technologies will serve as supporting illustrations thereof.

After visiting this lecture, you should have gained an overview and understanding of the Big Data landscape, which is the basis on which one can make informed decisions, i.e., pick and orchestrate the relevant technologies together for addressing each business use case efficiently and consistently.

This course gives an overview of database technologies and of the most important database design principles that lay the foundations of the Big Data universe. The material is organized along three axes: data in the large, data in the small, data in the very small. A broad range of aspects is covered with a focus on how they fit together in the big picture of the Big Data ecosystem.

- physical storage (HD4S, S3)
- logical storage (key-value stores, document stores, column stores, key-value stores, data warehouses)
- data formats and syntaxes (XML, JSON, CSV, XBRL)
- data shapes and models (tables, trees, graphs, cubes)
- an overview of programming languages with a focus on their type systems (SQL, XQuery, MDX)
- the most important query paradigms (selection, projection, joining, grouping, ordering, windowing)
- paradigms for parallel processing (MapReduce) and technologies (Hadoop, Spark)
- optimization techniques (functional and declarative paradigms, query plans, rewrites, indexing)
- applications.

We will also host two guest lectures to get insights from the industry: UBS and Google.

Large scale analytics and machine learning are outside of the scope of this course.

Papers from scientific conferences and journals. References will be given as part of the course material during the semester.

| Course Code | Course Title | W | 4 credits | 2V+1U | T. Hofmann
|-------------|--------------|---|-----------|-------|-------------
| 263-3210-00L | Deep Learning | W | 4 credits | 2V+1U | T. Hofmann
|-------------|--------------|---|-----------|-------|-------------
| 252-3610-00L | Smart Energy | W | 3 credits | 2G | F. Mattern, V. Tienfebeck
|-------------|--------------|---|-----------|-------|-------------
| 263-3800-00L | Advanced Operating Systems | W | 6 credits | 2V+2U+1A | T. Roscoe
|-------------|--------------|---|-----------|-------|-------------
| 263-4640-00L | Network Security | W | 6 credits | 2V+1U+2A | A. Peggir, T. Dübendorfer, S. Frei

Abstract: Deep learning is an area within machine learning that deals with algorithms and models that automatically induce multi-level data representations.

Objective: In recent years, deep learning and deep networks have significantly improved the state-of-the-art in many application domains such as computer vision, speech recognition, and natural language processing. This class will cover the fundamentals of deep learning and provide a rich set of hands-on tasks and practical projects to familiarize students with this emerging technology.

Prerequisites / notice: The participation in the course is subject to the following conditions:
1) The number of participants is limited to 120 students (MSc and PhDs).
2) Students must have taken the exam in Machine Learning (252-0535-00) or have acquired equivalent knowledge.

Abstract: The lecture covers the role of ICT for sustainable energy usage. Concepts of the emerging smart grid are outlined and approaches to motivate sustainable consumer choices are explained. The lecture combines technologies from ubiquitous computing and traditional ICT with insights from socio-psychological concepts and illustrates them with examples from actual applications.

Objective: Participants become familiar with the challenges related to sustainable energy usage, understand the principles of a smart grid infrastructure and its applications, know the role of ubiquitous computing technologies, can explain the challenges regarding security and privacy, can reflect the basics cues to induce changes in consumer behavior, develop a general understanding of the effects of a smart grid infrastructure on energy efficiency, and know how to apply the learning to related design projects.

Content:
- Background on energy generation and consumption; characteristics, potential, and limitations of renewable energy sources
- Introduction to energy economics
- Smart grid and smart metering infrastructures, virtual power plants, security challenges
- Demand management and home automation using ubiquitous computing technologies
- Changing consumer behavior with smart ICT
- Benefits challenges of a smart energy system

Abstract: This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems, with a particular emphasis on the challenges of modern hardware features. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.

Objective: The goals of the course are, firstly, to give students a broader perspective on OS design than that provided by knowledge of Unix or Windows, building on the material in a standard undergraduate operating systems class, and secondly, to provide them with practical experience in dealing directly with the concurrency, resource management, and abstraction problems confronting OS designers and implementers.

Content: This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems, with a particular emphasis on the challenges of modern hardware features. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.

Prerequisites / notice: The course is based around a milestone-oriented project, where students work in small groups to implement major components of a microkernel-based operating system. The final assessment will be a combination grades awarded for milestones during the course of the project, a final written report on the work, and a set of test cases on the final code.
Objective

Students are aware of current threats that Internet services and networked devices face and can explain appropriate countermeasures. Students know fundamental network security concepts. Students have an in-depth understanding of important security technologies. Students know how to configure a real firewall and know some penetration testing tools from their own experience.

Content

Risk management and the vulnerability lifecycle of software and networked services are discussed. Threats like denial of service, spam, worms, and viruses are studied in-depth. Fundamental security related concepts like identity, availability, authentication and secure channels are introduced. State of the art technologies like secure shell, network and transport layer security, intrusion detection and prevention systems, cross-site scripting, secure implementation techniques and more for securing the Internet and web applications are presented. Several case studies illustrate the dark side of the Internet and explain how to protect against current threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

This lecture is intended for students with an interest in securing Internet services and networked devices. Students are assumed to have knowledge in networking as taught in the Communication Networks lecture.

Prerequisites / notice

Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.

263-4650-00L Specification and Proof of Probabilistic Programs with W Applications to Security

4 credits 2V+1U A. McIver, C. C. Morgan

Objective

The course will introduce participants to semantic models for probabilistic programs. The semantics will provide the fundamental model for deriving generic properties of probabilistic systems, and as a context for proving soundness and completeness of proof techniques.

Content

Students in this course will learn new ways to specify and reason about quantitative properties of probabilistic programs. Both probabilistic programs' functional behaviour and their information-flow properties are important aspects of modern systems building, complementing existing methods of abstraction, nondeterminism and refinement. This course's objective is to give the students the necessary intellectual skills for rigorous reasoning about building such systems.

Literature

The course will follow the book "Abstraction, Refinement and Proof for Probabilistic Systems". Other material will consist of research papers which will be available in the secured area.

Prerequisites / notice

The course is intended for MSc and PhD students.

263-4655-00L Lattice Cryptography

W 4 credits 2V+1U V. Lyubashevsky

Objective

The course will introduce lattice-based cryptography, which is one of the main candidates for quantum-resistant cryptography.

Content

In this course, we will study lattice-based cryptography. We will cover the basic algorithms associated with integer lattices such as Gram-Schmidt orthogonalization, algorithms for finding short and near lattice vectors, as well as the critical algorithm for sampling lattice points according to a discrete Gaussian distribution. We will then proceed to build up a toolbox of lattice-based cryptographic primitives beginning from collision-resistant hash functions, then moving on to digital signatures, encryption, identity-based encryption, and fully-homomorphic encryption. Particular emphasis will be placed on concrete parameters and practical instantiations. For this purpose, we will also study cryptographic constructions based on the hardness of ideal lattices, which are ideals of polynomial rings.

Prerequisites / notice

There are no formal mathematical pre-requisites, but students should have "mathematical maturity", which entails dealing with abstract concepts and being comfortable with doing mathematical proofs. Some previous exposure to linear algebra, abstract algebra, and cryptography would be useful.

263-5001-00L Introduction to Finite Elements and Sparse Linear System Solving

W 4 credits 2V+1U P. Arbenz

Objective

The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that a typical for the FE method. We will consider direct and iterative methods.

Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.
Content

I. THE FINITE ELEMENT METHOD

(1) Introduction, model problems.
(2) 1D problems. Piecewise polynomials in 1D.
(3) 2D problems. Triangulations. Piecewise polynomials in 2D.
(4) Variational formulations. Galerkin finite element method.
(5) Implementation aspects.

II. DIRECT SOLUTION METHODS

(6) LU and Cholesky decomposition.
(7) Sparse matrices.
(8) Fill-reducing orderings.

III. ITERATIVE SOLUTION METHODS

(9) Stationary iterative methods, preconditioning.
(10) Preconditioned conjugate gradient method (PCG).
(11) Incomplete factorization preconditioning.
(12) Multigrid preconditioning.
(13) Nonsymmetric problems (GMRES, BiCGstab).
(14) Indefinite problems (SYMMLQ, MINRES).

Literature


Prerequisites / notice

Prerequisites: Linear Algebra, Analysis, Computational Science.
The exercises are made with Matlab.

263-5200-00L Data Mining: Learning from Large Data Sets W 4 credits 2V+1U A. Krause
Abstract Many scientific and commercial applications require insights from massive, high-dimensional data sets. This course introduces principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course both covers theoretical foundations and practical applications.
Content Topics covered:
- Dealing with large data (Data centers; Map-Reduce/Hadoop; Amazon Mechanical Turk)
- Fast nearest neighbor methods (Shingling, locality sensitive hashing)
- Online learning (Online optimization and regret minimization, online convex programming, applications to large-scale Support Vector Machines)
- Multi-armed bandits (exploration-exploitation tradeoffs, applications to online advertising and relevance feedback)
- Active learning (uncertainty sampling, pool-based methods, label complexity)
- Dimension reduction (random projections, nonlinear methods)
- Data streams (Sketches, coresets, applications to online clustering)
- Recommender systems
Prerequisites / notice Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.

263-5210-00L Probabilistic Artificial Intelligence W 4 credits 2V+1U S. Tschiatschek
Abstract This course introduces core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.
Objective How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit "intelligent" behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. The course is designed for upper-level undergraduate and graduate students.
Content Topics covered:
- Search (BFS, DFS, A*), constraint satisfaction and optimization
- Tutorial in logic (propositional, first-order)
- Probability
- Bayesian Networks (models, exact and approximative inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
- Probabilistic planning (MDPs, POMDPs)
- Reinforcement learning
- Combining logic and probability
Prerequisites / notice Solid basic knowledge in statistics, algorithms and programming

263-5902-00L Computer Vision W 6 credits 3V+1U+1A L. Van Gool, V. Ferrari, A. Geiger

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 336 of 1571
Abstract

The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

Objective

The objectives of this course are:

1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve those.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

Content

Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

Prerequisites / notice

It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>ECTS</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>263-5903-00L</td>
<td>Computational Regularity</td>
<td>W</td>
<td>4</td>
<td>Y. Liu, M. R. Oswald</td>
</tr>
<tr>
<td>227-0778-00L</td>
<td>Hardware/Software Codeign</td>
<td>W</td>
<td>6</td>
<td>L. Theile</td>
</tr>
<tr>
<td>401-0647-00L</td>
<td>Introduction to Mathematical Optimization</td>
<td>W</td>
<td>5</td>
<td>D. Adjiashvili</td>
</tr>
<tr>
<td>636-0007-00L</td>
<td>Computational Systems Biology</td>
<td>W</td>
<td>6</td>
<td>J. Stelling</td>
</tr>
<tr>
<td>636-0017-00L</td>
<td>Computational Biology</td>
<td>W</td>
<td>4</td>
<td>T. Stadler, C. Magnus</td>
</tr>
</tbody>
</table>

**Computational Regularity**

Objective

Computation forms the key component of this course which links theory and applications. Students will witness effective computational models with concrete applications in robotics, computer vision, computer graphics and medical image analysis. The emphasis is on hands-on computational experience and on producing state of the art, publishable research projects. During the semester, we shall start with intuition, learn the basic mathematical concepts and develop state of the art computer algorithms for real-world problems. Our goal is to build "bridges" connecting, symmetry, symmetry group theory, general and specific regularities and real-world applications.

Content

Regularity is an essential and ubiquitous concept in nature, science and art. Numerous biological, natural or man-made structures exhibit regularities, abstracted by symmetries, as a fundamental design principle or as an essential aspect of their function. Whether by evolution or by design, symmetry implies potential structural efficiencies that make it universally appealing. Much of our understanding of the world is based on the perception and recognition of recurring structures, and so is our sense of beauty. With increasing amount and variety of digitized data, seeking for patterns systematically has become increasingly pertinent and necessary. This course concentrates on rigorous theory, keen observations and computational discovery of patterns in various data forms in our daily life and research. We aim to develop effective computational treatments of regularity to capture real world regular or near-regular patterns in spite of uncertainty.

**Hardware/Software Codeign**

Objective

The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.

Content

The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.

**Introduction to Mathematical Optimization**

Objective

The goal of the course is to obtain a good understanding of some of the most fundamental mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems. The students will also practice applying the learned models to problems in engineering.

Content

Topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...)
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...)
- Modelling with mathematical optimization: applications of mathematical programming in engineering.

**Computational Systems Biology**

Objective

The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content

Biological models with concrete applications in robotics, computer vision, computer graphics and medical image analysis. The emphasis is on hands-on practical applications, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

**Computational Biology**

Objective

The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data.

Content

Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.

Literature


Lecture notes

https://www.ethz.ch/content/specialinterest/bsse/computational-systems-biology/en/education/lectures/csb/LectureMaterial.html


Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:

- stochastic models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics

Attendees will apply these concepts to a number of applications yielding biological insight into:

- epidemiology
- pathogen evolution
- macroevolution of species

The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylogenetics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

Slides of the lecture will be available online.
https://www.bsse.ethz.ch/cevo/education/cb-materials.html

Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

### Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-4202-00L</td>
<td>Seminar in Theoretical Computer Science</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>E. Weizl, B. Gärtner, M. Hoffmann, J. Lengler, A. Steiger, Budakov</td>
</tr>
<tr>
<td>252-4601-00L</td>
<td>Current Topics in Information Security</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>D. Basin, S. Capkun, A. Perrig</td>
</tr>
<tr>
<td>252-5051-00L</td>
<td>Advanced Topics in Machine Learning</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>J. M. Buhmann, T. Hofmann, A. Krause, G. Rätsch</td>
</tr>
<tr>
<td>252-5701-00L</td>
<td>Advanced Topics in Computer Graphics and Vision</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>M. Gross, O. Sorkine Hornung</td>
</tr>
</tbody>
</table>

**Prerequisites and notice**

- Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

### Literature

- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST
- *Yang, Z. 2006. Computational Molecular Evolution.*
- *Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST*

### Objective

- Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:
  - stochastic models in molecular evolution
  - phylogenetic & phylodynamic inference
  - maximum likelihood and Bayesian statistics

- Attendees will apply these concepts to a number of applications yielding biological insight into:
  - epidemiology
  - pathogen evolution
  - macroevolution of species

### Content

The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylogenetics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

Slides of the lecture will be available online.
https://www.bsse.ethz.ch/cevo/education/cb-materials.html

Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

### Lectures

- **Advanced Topics in Machine Learning**
- **Advanced Topics in Computer Graphics and Vision**

### Number of participants limited to 24.

This seminar covers advanced topics in computer graphics, such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each time the course is offered, a collection of research papers is selected and each student presents one paper to the class and leads a discussion about the paper and related topics.

The goal is to get an in-depth understanding of actual problems and research topics in the field of computer graphics as well as improve presentations and critical analysis skills.
This seminar covers advanced topics in computer graphics, including both seminal research papers as well as the latest research results. Each time the course is offered, a collection of research papers are selected covering topics such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each student presents one paper to the class and leads a discussion about the paper and related topics. All students read the papers and participate in the discussion.

Individual research papers are selected each term. See http://graphics.ethz.ch/ for the current list.

This seminar is an opportunity to become familiar with current research in software engineering and more generally with the methods and challenges of scientific research.

Each student will be asked to study some papers from the recent software engineering literature and review them. This is an exercise in critical review and analysis. Active participation is required (a presentation of a paper as well as participation in discussions).

The aim of this seminar is to introduce students to recent research results in the area of programming languages and software engineering. To accomplish that, students will study and present research papers in the area as well as participate in paper discussions. The papers will span topics in both theory and practice, including papers on program verification, program analysis, testing, programming language design, and development tools. A particular focus will be on domain-specific languages.

The publications to be presented will be announced on the seminar home page at least one week before the first session.

The seminar will cover topics related to data processing using new hardware in general and hardware accelerators (GPU, FPGA, specialized processors) in particular.

Number of participants limited to 22.

The seminar will cover topics related to data processing using new hardware in general and hardware accelerators (GPU, FPGA, specialized processors) in particular.

The general application areas are big data and machine learning. The systems covered will include systems from computer architecture, high performance computing, data appliances, and data centers.

Number of participants limited to 24.

To improve this the seminar will use a case-study format where all students read the same paper each week but fulfill different roles and hence prepare with different viewpoints in mind.

Student roles/instructions

The seminar is organized with each student taking one of the following roles on a rotating basis:

Conference Reviewer (e.g., reviewer of UIST/ICML/PLDI): Complete a full critical review of the paper. Use the original review from and come to a recommendation whether the paper should be accepted or not.

Historian: Find out how this paper sits in the context of the related work. Use bibliography tools to find the most influential papers cited by this work and at least one paper influenced by the work (and summarize the two papers).

PhD student: Propose a follow-up project for your own research based on this paper - importantly the project should be directly inspired by the paper or even use/extend the method proposed.

Hacker: Implement a (simplified) version of the core aspect of the paper. Prepare a demo for the seminar. In case the complexity is too high perform an in-depth analysis of reproducibility of the paper.

Detective: Find out background information about the authors. Where did they work when the paper was published; what was their role; who else have they published with; which prior work of the authors may have inspired the current paper? Students may contact the authors (but need to adhere to politeness and courteous manners and stay on topic in their conversations).

All students (every week): Come up with alternative title; find a missing result that the paper should have included.
Abstract

Develop an understanding of selected topics in the area of molecular algorithms, and the practice of scientific research.

Objective

Study and understanding of selected topics of interest in molecular algorithms such as: Computational Power of Molecular Algorithms, Molecular Algorithms for Solving Fundamental Tasks (Majority, Leader Election, Counting), Complexity Lower Bounds, Implementations of Algorithms in DNA.

Content

This seminar will familiarize the students with current research on molecular algorithms, with a focus on algorithms executable in DNA. We will have an introductory lecture covering the basics of molecular computational models, and the underlying bio-chemical phenomena. Subsequently, we will read and present selected research papers, focusing on their algorithmic content. No prior knowledge of biology or chemistry will be required.

Literature

Selected research articles.

Prerequisites / notice

The course will require a good understanding of Randomized Algorithms. Hence, you must have passed our “Randomized Algorithms” class (or have acquired equivalent knowledge, in exceptional cases). No prior knowledge of biology or chemistry will be assumed. The basics will be presented in an introductory lecture.

227-0559-00L Seminar in Distributed Computing

| 2 credits | 2S |
---|---|
| W | R. Wattenhofer |

Abstract

In this seminar participating students present and discuss recent research papers in the area of distributed computing. The seminar consists of algorithmic as well as systems papers in distributed computing theory, peer-to-peer computing, ad hoc and sensor networking, or multi-core computing.

Objective

In the last two decades, we have experienced an unprecedented growth in the area of distributed systems and networks; distributed computing now encompasses many of the activities occurring in today’s computer and communications world. This course introduces the basics of distributed computing, highlighting common themes and techniques. We study the fundamental issues underlying the design of distributed systems: communication, coordination, synchronization, uncertainty. We explore essential algorithmic ideas and lower bound techniques.

In this seminar, students present the latest work in this domain.

Seminar language: English

Content

Different each year. For details see: www.disco.ethz.ch/courses.html

Lecture notes

Slides of presentations will be made available.

Literature

Papers. The actual paper selection can be found on www.disco.ethz.ch/courses.html.

Certificate of Advanced Studies in Computer Science - Key for Type

| O | Compulsory |
---|---|
| W+ | Eligible for credits and recommended |
| W | Eligible for credits |
| E- | Recommended, not eligible for credits |
| Z | Courses outside the curriculum |
| Dr | Suitable for doctorate |

Key for Hours

| V | lecture |
---|---|
| G | lecture with exercise |
| U | exercise |
| S | seminar |
| K | colloquium |
| P | practical/laboratory course |
| A | independent project |
| D | diploma thesis |
| R | revision course / private study |

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### CAS in Nutrition for Disease Prevention and Health

#### Disciplinary Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6101-00L</td>
<td>Dietary Etiologies of Chronic Disease</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. B. Zimmermann</td>
</tr>
<tr>
<td>Abstract</td>
<td>To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>There is no script. Powerpoint presentations will be made available on-line to students.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6403-00L</td>
<td>Nutrition and Performance</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>S. Mettler, M. B. Zimmermann</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>English</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6301-00L</td>
<td>Selected Topics in Physiology Related to Nutrition</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>W. Langhans</td>
</tr>
<tr>
<td>Abstract</td>
<td>Gives the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Some basic knowledge in physiology is recommended for this course, which revisits important physiological topics, emphasizing their relation to nutrition. The aim is to give the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand. For students with a background in medicine, pharmacy or biology, the course is useful as a review of previously acquired knowledge. Major topics are basic neuroanatomy and neurophysiology; general endocrinology; the physiology of taste and smell; nutrient digestion and absorption; intermediary metabolism and energy homeostasis; and some aspects of cardiovascular physiology and water balance.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Handouts for each lecture will be made available every week: <a href="http://www.fpb.ethz.ch/teaching/handouts.html">http://www.fpb.ethz.ch/teaching/handouts.html</a></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

#### CAS in Nutrition for Disease Prevention and Health - Key for Type

| O  | Compulsory |
| W+ | Eligible for credits and recommended |
| W  | Eligible for credits |
| E- | Recommended, not eligible for credits |
| Z  | Courses outside the curriculum |
| Dr | Suitable for doctorate |

#### Key for Hours

| V  | lecture |
| G  | lecture with exercise |
| U  | exercise |
| S  | seminar |
| K  | colloquium |
| P  | practical/laboratory course |
| A  | independent project |
| D  | diploma thesis |
| R  | revision course / private study |

ECTS: European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
### Chemistry (General Courses)

#### General Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0073-00L</td>
<td>Radiochemistry</td>
<td>E-</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Badertscher</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Principles and phenomena around radioactivity. Knowledge of the most important phenomena in relation with radioactivity. Knowledge of the principles of radiation protection. Ability to judge dangerous situations in handling radioactive materials, geopolitically as well as locally at ones own working place.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Knowledge of the most important phenomena in relation with radioactivity. Knowledge of the principles of radiation protection. Ability to handle radioactive material.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Content</strong></td>
<td>Structure and properties of atomic nuclei, mathematical description of the radioactive decay, decay types, interaction of radiation with matter, detectors for ionizing radiation, radiation protection, principles of isotope separation, nuclear power plants, major nuclear accidents. Additional topics may be suggested by the students.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>A script is available free of charge.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Weitere Literaturangaben werden nach Bedarf in der Vorlesung abgegeben.

| 529-0075-00L   | Radiochemistry (Practical Training)       | E-   | 4 credits | 4P    | M. Badertscher          |
| **Abstract**   | Handling open and closed radioactive sources. Aspects of radiation protection. Handling detectors for ionizing radiation. |      |       |                   |                          |
| **Objective**  | Knowledge of the most important phenomena in relation with radioactivity. Knowledge of the principles of radiation protection. Ability to handle radioactive material. |      |       |                   |                          |
| **Content**    | Handling open and closed radioactive sources. Getting accustomed to a variety of instruments and detectors for various kinds of ionizing radiation. Acquisition of working techniques under consideration of radiation protection. |      |       |                   |                          |
| **Lecture notes** | Comprehensive material is available online. |      |       |                   |                          |

| **Abstract**   | Institute-Seminar covering current research Topics in Physical Chemistry |      |       |                   |                          |

| 529-1100-00L   | Fragrance Chemistry                       | E-   | 1 credit | 1V    | P. Kraft                |
| **Abstract**   | The lecture provides a journey into the molecular world of scents from the chemical secrets behind Chanel N°5 to structure-odor relationships, industrial processes, and total synthesis of terpenoids. Each subunit is centered on one odorant family and highlights a certain class of chemical reactions, illustrated by prominent perfumery examples. |      |       |                   |                          |
| **Objective**  | After completion of this lecture module the students know all the major perfumery materials of the important odor families with their academic and industrial syntheses, their olfactory properties, their usage, their historic perspective, and today's economic importance. The students can explain the significance of important building blocks and industrial transformations, and can estimate how attractive chemical processes are on large scale. They can retrosynthetically plan academic and industrial syntheses of fragrant compounds and terpenoids, and the acquired knowledge on structure-odor relationships enables them to predict and design new odorants. The students can approximate the conformational space of odorants and especially macrocycles on the basis of simple rules, and know how olfactophore models are used. The students understand and can explain the molecular mechanism of smell, the biosynthesis of terpenes, and the basics of perfumery composition. The latter enables them to further their education in perfumery at specialized Universities such as the ISIPCA in Versailles; yet, the student also knows about the links of Fragrance Chemistry with Pharmaceutical Chemistry and the Specialty Chemicals business in general. |      |       |                   |                          |

| 529-0688-00L   | Safety Lecture for Assistants             | Z    | 0 credits |       | T. Mäder                |
| **Abstract**   | Safety-Praxis und Riskmanagement in Laboratorien |      |         |       |                          |
| **Objective**  | Gute Safety-Praxis                        |      |         |       |                          |
| **Content**    | Safety-Regeln, Riskmanagement im Labor, Safety-Parcours |      |         |       |                          |

### Chemistry (General Courses) - Key for Type

- **Dr**: Suitable for doctorate
- **O**: Compulsory
- **W+**: Eligible for credits and recommended
- **W**: Eligible for credits
- **E-**: Recommended, not eligible for credits
- **Z**: Courses outside the curriculum

### Key for Hours

- **V**: lecture
- **G**: lecture with exercise
- **U**: exercise
- **S**: seminar
- **K**: colloquium
- **P**: practical/laboratory course
- **A**: independent project
- **D**: diploma thesis
- **R**: revision course / private study

- **ECTS**: European Credit Transfer and Accumulation System
- **Special students and auditors need special permission from the lecturers.**

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### Chemistry Bachelor

**1. Semester**

#### Compulsory Subjects First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0011-02L</td>
<td>General Chemistry (Inorganic Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>A. Togni</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction to the chemistry of ionic equilibria: Acids and bases, redox reactions, formation of coordination complexes and precipitation reactions</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Understanding and describing ionic equilibria from both a qualitative and a quantitative perspective</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Content</strong></td>
<td>Chemical equilibrium and equilibrium constants, mono- and polyprotic acids and bases in aqueous solution, calculation of equilibrium concentrations, acidity functions, Lewis acids, acids in non-aqueous solvents, redox reactions and equilibria, Galvanic cells, electrode potentials, Nernst equation, coordination chemistry, stepwise formation of metal complexes, solubility</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Copies of the course slides as well as other documents will be provided as pdf files via the moodle platform.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>529-0011-03L</td>
<td>General Chemistry (Organic Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>H. Wennemers</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction to Organic Chemistry. Classical structure theory, stereochemistry, chemical bonds and bonding, symmetry, nomenclature, organic thermochemistry, conformational analysis, basics of chemical reactions.</td>
<td></td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Introduction to the structures of organic compounds as well as the structural and energetic basis of organic chemistry.</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Introduction to the history of organic chemistry, introduction to nomenclature, learning of classical structures and stereochemistry: isomerism, Fischer projections, CIP rules, point groups, molecular symmetry and chirality, topicity, chemical bonding: Lewis bonding model and resonance theory in organic chemistry, description of linear and cyclic conjugated molecules, aromaticity, Huckel rules, organic thermochemistry, learning of organic chemistry reactions, intermolecular interactions.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Copies of the course slides as well as other documents will be provided as pdf files via the moodle platform.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>529-0011-01L</td>
<td>General Chemistry (Physical Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>F. Merkt</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Atomic structure and structure of matter; Atomic orbitals and energy levels; Quantum mechanical atom model; Chemical bonding; Equations of state.</td>
<td></td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Introduction to Physical Chemistry</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Atomic structure and structure of matter: atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic orbitals and energy levels; ionisation energies, atomic spectroscopy, term values and symbols. Quantum mechanical atom model: wave-particle duality, the uncertainty principle, Schrödinger’s equation, the hydrogen atom, construction of the periodic table of the elements. Chemical bonding: ionic bonding, covalent bonding, molecular orbitals. Equations of state: ideal gases</td>
<td></td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>See homepage of the lecture.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Literature</strong></td>
<td>See homepage of the lecture.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Voraussetzungen: Maturastoff. Insbesondere Integral- und Differentialrechnung.</td>
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</tr>
<tr>
<td>551-0015-00L</td>
<td>Biology I</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>R. Glockshuber, E. Hafen</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject.</td>
<td></td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.</td>
<td></td>
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</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Zur Vorlesung Biologie I gibt es während der Prüfungssesssion eine einstündige, schriftliche Prüfung. Die Vorlesung Biologie II wird separat geprüft.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>401-0271-00L</td>
<td>Mathematical Foundations I: Analysis A</td>
<td>O</td>
<td>5 credits</td>
<td>3V+2U</td>
<td>L. Keller</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction to calculus in one dimension. Building simple models and analysing them mathematically. Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.</td>
<td></td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Introduction to calculus in one dimension. Building simple models and analysing them mathematically.</td>
<td></td>
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</tr>
</tbody>
</table>
529-0001-00L  Introduction to Computer Science

Abstract
Introduction to UNIX, data representation, introduction to C++ programming, errors, algorithms, computer architecture, sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, software engineering.

For more information: www.csms.ethz.ch/education/infol

Objective
Discuss fundamentals of computer architecture, languages, algorithms and programming with an eye to their application in the area of chemistry, biology and material science.

Content
Minimal introduction to UNIX, Data representation and processing, algorithms and programming in C++, Errors, programming guidelines, efficiency, computer architecture, algorithms for sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, style, software engineering.

Literature
See: www.csms.ethz.ch/education/infol

Prerequisites / notice
Since the exercises on the computer do convey test essentially different skills as those being conveyed during the lectures and tested at the written exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/infol

Laboratory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0011-04L</td>
<td>Practical Course General Chemistry ■</td>
<td>O</td>
<td>8</td>
<td>12P</td>
<td>H. V. Schönberg, E. C. Meister</td>
</tr>
</tbody>
</table>

Abstract
Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox reactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration)

Objective
Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kjeldahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements, metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration)

Content
The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

Lecture notes
http://www.gruetzmacher.ethz.ch/education/labcourses

Prerequisites / notice
Compulsory: online enrolment latest one week prior start of the semester

3. Semester

Compulsory Subjects Examination Block I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0121-00L</td>
<td>Inorganic Chemistry I</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>A. Mezzetti</td>
</tr>
</tbody>
</table>

Abstract
Introduction to the binding theory in complexes of the transition metals. Interpretation of structure, bonding, and spectroscopic properties.

Objective

Content
Can be bought at the HCI-shop


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0221-00L</td>
<td>Organic Chemistry I</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>F. Diederich, C. Schaack</td>
</tr>
</tbody>
</table>

Abstract
Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetal, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Objective
Acquisition of a basic repertoire of synthetic methods including important reactions of aldehydes, ketones, carboxylic acids and carboxylic acid derivatives, as well as eliminations and fragmentations. Particular emphasis is placed on the understanding of reaction mechanisms and the correlation between structure and reactivity. A deeper understanding of the concepts presented during the lecture is reached by solving the problems handed out each time and discussed one week later in the exercise class.

Content
Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetal, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Lecture notes
A pdf file of the printed lecture notes is provided online. Supplementary material may be provided online.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0422-00L</td>
<td>Physical Chemistry II: Introduction to Chemical</td>
<td>O</td>
<td>4</td>
<td>3V+1U</td>
<td>H. J. Wörner</td>
</tr>
</tbody>
</table>

No set textbooks. Optional literature will be proposed at the beginning of the class and in the lecture notes.

ECTS
Reaction Kinetics

Abstract

Objective
Introduction to Chemical Reaction Kinetics

Content
Fundamental concepts: rate laws, elementary reactions and composite reactions, molecularity, reaction order. Experimental methods in reaction kinetics up to new developments in femtosecond kinetics. Simple chemical reaction rate theories: temperature dependence of the rate constant and Arrhenius equation, collision theory, reaction cross-section, transition state theory. Reaction mechanisms and complex kinetic systems, approximation techniques, chain reactions, explosions and detonations. Homogeneous catalysis and enzyme kinetics.

Lecture notes

Literature

402-0043-00L Physics I O 4 credits 3V+1U T. Esslinger

Abstract
Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

Objective
The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.

Content
Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids)
Periodic Motion and Waves (periodic motion, mechanical waves, acoustics).

Lecture notes
The lecture follows the book "Physics" by Paul A. Tipler.

Literature
Paul A. Tipler and Gene P. Mosca, Physics (for Scientists and Engineers), W. H. Freeman and Company

529-0051-00L Analytical Chemistry I O 3 credits 3G D. Günther, M.O. Ebert, R. Zenobi

Abstract
Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications

Objective
Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:
Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.
UV/VIS spectroscopy: Basics, interpretation of electron spectra. Circular dichroism (CD) and optical rotation dispersion (ORD).

Lecture notes
Script will be for the production price

Literature
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

Prerequisites / notice
Excercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounts" (4th semester) is recommended.

401-0373-00L Mathematics III: Partial Differential Equations O 4 credits 2V+1U F. Da Lio

Abstract

Objective
The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.
Examples of partial differential equations
- Classification of PDEs
- Superposition principle

One-dimensional wave equation
- D'Alembert's formula
- Duhamel's principle

Fourier series
- Representation of piecewise continuous functions via Fourier series
- Examples and applications

Separation of variables
- Resolution of wave and heat equation
- Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

Laplace equation
- Resolution of the Laplace equation on rectangle, disk and annulus
- Poisson formula
- Mean value theorem and maximum principle

Fourier transform
- Derivation and Definition
- Inverse Fourier transformation and inversion formula
- Interpretation and properties of the Fourier transform
- Resolution of the heat equation

Laplace transform
- Definition, motivation and properties
- Inverse Laplace transform of rational functions
- Application to ordinary differential equations

Lecture notes
There are available some Lecture Notes in English and also in German of the Professor. These can be found following the links provided under the tab ‘Lernmaterialien’.

Literature
2) Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations, Cambridge University Press
3) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (only Chapters 1,2,6,11)

Prerequisites / notice
It is required a minimal background of: 1) multivariable functions (Riemann integrals in two or three variables, change of variables in the integrals through the Jacobian, partial derivatives, differentiability, Jacobian) 2) numerical and functional sequences and series, basic knowledge of ordinary differential equations.

Laboratory Courses
Number Title Type ECTS Hours Lecturers
529-0129-00L Inorganic and Organic Chemistry II O 11 credits 16P A. Mezzetti, A. Togni

Abstract
Introduction to the experimental methods of Inorganic Chemistry

Objective
The teaching laboratory offers an insight into different aspects of Inorganic Chemistry, including solid state chemistry, organometallic chemistry, kinetics, etc. The synthesis, characterization and analysis of inorganic compound are a main topic. Emphasis is given to scientific writing (experiment reports).

Content
Inorganic chemistry part: Synthesis and analysis of elemento-organic compounds, metal complexes, and organometallic compounds. Introduction to Schlenk techniques, solid state synthesis, and kinetics. Introduction in the chemistry library: literature data banks and collections of spectra.

Organic synthesis with organometallic compounds and catalysts: Experiments in the framework of a selected specialised project. Possible projects: Rh catalysed asymmetric hydrogenation of enamides, Mn-catalysed epoxidation of olefins, Cu catalysed Diels-Alder reactions, synthesis of organo-boron compounds and Pd catalysed coupling with halides, Ru catalysed transfer hydrogenation.

Lecture notes
A manual is distributed in the teaching laboratory.

Prerequisites / notice
Prerequisites:
- Practical Course General Chemistry (1. Semester, 529-0011-04)
- Practical Course Inorg. and Org. Chemistry I (2. Sem., 529-0230)
- Attendance of Course Inorg. Chemistry 1 (3. Sem., 529-0121)

If necessary, access priority will be settled according to the results of the first-year examinations.

5. Semester
Compulsory Subjects Examination Block II
Number Title Type ECTS Hours Lecturers
529-0132-00L Inorganic Chemistry III: Organometallic Chemistry and O 4 credits 3G A. Togni, A. Mezzetti

Homogeneous Catalysis

Abstract
Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbylonylation, C-C bond-forming and related reactions.

Objective
Towards an understanding of the fundamental coordination-chemical and mechanistic aspects of transition-metal chemistry relevant to homogeneous catalysis.

Content
Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbylonylation, C-C bond-forming and related reactions.

529-0231-00L Organic Chemistry III: Introduction to Asymmetric O 4 credits 3G E. M. Carreira

Synthesis

Abstract
Methods of Asymmetric Synthesis

Objective
Understanding of the basic principles of diastereoselective synthesis
Content
Conformational analysis: acyclic and cyclic systems; Diastereoselective sigmatropic rearrangements; Diastereoselective Carbonyl addition reactions; Cram- and Felkin-Anh models, carbonyl Lewis acid interactions, chelate controlled reactions; chemistry of enolates, selective formation; asymmetric enolate alkylation; aldo reactions, allyl- and crotly-metal chemistry; cyclisations, Baldwin rules; Diastereoselective olefin functionalization: hydroboration, dihydroxylation, epoxidation.

Literature

529-0432-00L Physical Chemistry IV: Magnetic Resonance O 4 credits 3G B. H. Meier, M. Ernst, G. Jeschke, R. Riek

Abstract
Theoretical foundations of magnetic resonance (NMR,EPR) and selected applications.

Objective
Introduction to magnetic resonance in isotropic and anisotropic phase.

Content
The course gives an introduction to magnetic resonance spectroscopy (NMR and EPR) in liquid, liquid crystalline and solid phase. It starts from a classical description in the framework of the Bloch equations. The implications of chemical exchange are studied and two-dimensional exchange spectroscopy is introduced. An introduction to Fourier spectroscopy in one and two dimensions is given and simple ‘pulse trickery’ is described. A quantum-mechanical description of magnetic resonance experiments is introduced and the spin Hamiltonian is derived. The chemical shift term as well as the scalar, dipolar and quadrupolar terms are discussed. The product-operator formalism is introduced and various experiments are described, e.g. polarization transfer. Applications in chemistry, biology, physics and medicine, e.g. determination of 3D molecular structure of dissolved molecules, determination of the structure of paramagnetic compounds and imaging (MRI) are presented.

Lecture notes
handed out in the lecture (in english)

Literature
see http://www.ssnmr.ethz.ch/education/PC_IV_Lecture

Laboratory Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>

Abstract
Laboratory experiments to acquire a profound knowledge of spectroscopical methods and techniques in chemistry. Evaluation and visualization of measurement data. Writing lab reports.

Objective
Laboratory experiments to acquire a profound knowledge of spectroscopical methods and techniques in chemistry. Evaluation and visualization of measurement data. Writing lab reports.

Content
Laboratory experiments: UV/VIS spectroscopy, luminescence spectroscopy, FT infrared spectroscopy, dye laser, light diffraction and refraction, laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), FT nuclear magnetic resonance spectroscopy (NMR), electron paramagnetic resonance spectroscopy (EPR), atomic force microscopy (AFM), Fourier transform methods.

Lecture notes
Detailed documents to each experiment will be handed out.

Prerequisites / notice
Praktikum Physikalische Chemie (529-0054-00) or Praktikum Physikalische Chemie (529-0054-01).

Electives

Inorganic Chemistry

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0141-00L</td>
<td>Physical Methods for Inorganic Chemistry</td>
<td>W</td>
<td>6 credits</td>
<td>3G</td>
<td>D. Günther, J. Koch, R. Verel, M. D. Wörle</td>
</tr>
</tbody>
</table>

Abstract
Introduction into the important methods for structural analysis (solid state NMR), crystal structure analysis and surface analysis techniques and their applications.

Objective
Knowledge in solid state NMR, crystal structure analysis and surface analytical techniques relevant for inorganic materials.

Content
This lecture course consists of three parts 1) Solid state NMR 2) Surface and direct solid analysis 3) Crystal structure analysis. Most important fundamentals of the individual methods will be presented and details will be explained on most relevant inorganic applications.

Lecture notes
Will be given during the lectures.

Physical Chemistry

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0441-00L</td>
<td>Signal Processing</td>
<td>W</td>
<td>6 credits</td>
<td>3G</td>
<td>G. Jeschke, M. Yuilkov</td>
</tr>
</tbody>
</table>

Abstract
Introduction of the basics of signal processing in spectroscopy. Fourier transformation, linear response theory, stochastic signals, digital data processing, Fourier spectroscopy.

Objective
Basics of signal processing in spectroscopy.

Content

Lecture notes
Script available

Analytical Chemistry

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0041-00L</td>
<td>Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics</td>
<td>W</td>
<td>6 credits</td>
<td>3G</td>
<td>R. Zenobi, M. Badertscher, B. Hattendorf, P. Martinez-Lozano Sinues</td>
</tr>
</tbody>
</table>

Abstract
Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics.

Objective
Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

Content
Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation. Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods. Methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods). Employment of computer science for processing data in chemical analysis (chemometrics).

Lecture notes
lecture notes will be available in the lecture at production cost.

Literature
Information about relevant literature will be available in the lecture & in the lecture notes.

Evans’ Problems in Organic Chemistry App
Prerequisites / notice

Exercises are an integral part of the lecture.

Prerequisites:
529-0051-00 "Analytische Chemie I (3. Semester)"
529-0058-00 "Analytische Chemie II (4. Semester)"
(or equivalent)

## Biological Chemistry

### Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---

**Abstract**
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Objective**
Structure, function, and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Content**
Structure, function, and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Lecture notes**
No script

**Literature**
Mainly based on recent original literature, a detailed list will be distributed during the first lecture

### Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
529-0240-00L | Chemical Biology - Peptides | W | 6 credits | 3G | H. Wennemers

**Abstract**
An advanced course on the synthesis, properties and function of peptides in chemistry and biology.

**Objective**
Knowledge of the synthesis, properties and function of peptides in chemistry and biology.

**Content**
Advanced peptide synthesis, conformational properties, combinatorial chemistry, therapeutic peptides, peptide based materials, peptides in nanotechnology; peptides in asymmetric catalysis.

**Lecture notes**
Citations from the original literature relevant to the individual lectures will be assigned weekly.

**Literature**

## Chemical Aspects of Energy

### Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
529-0659-00L | Electrochemistry | W | 6 credits | 3G | P. Novák

**Abstract**

**Objective**
Towards the end of the course the students will understand the basics of electrochemistry and will be able to describe and calculate electrochemistry-related matters in industrial processes and products.

**Content**

## Chemical Crystallography

### Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
529-0039-00L | Principles of Crystal Structure Determination | W | 6 credits | 3G | M. D. Wörle

**Abstract**
An introduction to the principles of X-ray diffraction and crystal structure determination as it relates to Chemistry

**Objective**
To gain an understanding of the principles of crystal structure determination by X-ray diffraction.

**Content**
Basic crystallographic concepts: Unit cells, Bravais lattices, Laue symmetry, crystal classes (point groups), space groups, crystal growth, instrumentation, diffraction of X-rays by crystals: physical and geometric basics, powder and single crystal methods, structure solution and modelling, interpretation of crystal structure data; internal coordinates for structure description: atom spacing, co-ordination polyhedra, bond angles, torsion angles; intermolecular interactions, absolute configuration determination. Overview of inorganic, organic and macromolecular databases.

**Lecture notes**
The script and exercises will be distributed weekly in loose form

**Literature**
Main reference

2. Additional literature

## Computational Chemistry

Data: 06.11.2018 12:57
Autumn Semester 2016
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### Algorithms and Programming in C++

**Number**: 529-0002-00L  
**Title**: Algorithms and Programming in C++  
**Type**: W  
**ECTS**: 6 credits  
**Hours**: 3G  
**Lecturers**: S. Riniker

#### Abstract
Introduction to algorithms (special focus on chemistry): Design of algorithms, data structures, search and sort algorithms, graphs, numerical algorithms, algorithms in cheminformatics, machine learning and cheminformatics  
Computer language: C++

#### Objective
Development of programming skills and craftsmanship in order to be able to deal with the complexity of computer applications in chemistry.

#### Content
- Introduction to algorithms (special focus on chemistry): Design of algorithms, data structures, search and sort algorithms, graphs, numerical algorithms, algorithms in cheminformatics, machine learning and cheminformatics  
- Computer language: C++

#### Lecture notes
Script (in English) will be available

#### Literature

#### Prerequisites / notice
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

### Basic Polymer Synthesis

**Number**: 529-0947-00L  
**Title**: Basic Polymer Synthesis  
**Type**: W  
**ECTS**: 6 credits  
**Hours**: 3G  
**Lecturers**: A. D. Schlueter

#### Abstract
Please note that this course will be offered for the last time in the autumn semester of 2017.

#### Objective
The students should gain an overview of important polymerization procedures, learn how to deal with chemical structures and reactivities, and be able to suggest reasonable synthetic pathways to a given polymer structure. Aspects like achievable molar masses in dependence of the method used and structure perfection play a role throughout.

#### Content
I. Anionic polymerization  
1. General  
2. Living polymerization  
3. Group transfer polymerization (GTP)  
4. Some recent developments  

II. Cationic polymerization  
1. General  
2. Some applications (macromonomer and telechelics)  

III. Ziegler/Natta- and metallocene polymerization  
1. General  
2. Mechanism  
3. Some applications  

IV. Ring-opening metathesis polymerization  
1. Comments on history  
2. Monomers, catalysts, polymer structures  
3. Mechanism, direct NMR monitoring  
4. Termination  
5. Examples

V. Controlled radical polymerization  
1. Nitroxide mediated polymerization (NMP)  
2. Atom transfer radical polymerization (ATRP)

#### Lecture notes
A script will not be provided. For all projections shown, however, paper copies will be distributed.

#### Literature
There is no specific literature recommendation. Numerous references will be provided for an easy access to the original literature.

#### Prerequisites / notice
The course will be taught in English. Complicated expressions will be explained in German. Questions can be asked in both languages. The examination will be in English; answers are acceptable in both languages.

PhD students who need recognized credit points are required to pass the written exam.

### Introduction to Environmental Chemistry and Ecotoxicology

**Number**: 529-0037-01L  
**Title**: Introduction to Environmental Chemistry and Ecotoxicology  
**Type**: W  
**ECTS**: 4 credits  
**Hours**: 3G  
**Lecturers**: K. Fenner, C. Bogdal, J. Hollender

#### Abstract
Production and use of chemicals also introduces them into the environment. This course introduces chemistry students to environmental chemistry, ecotoxicology and trace analysis. Partitioning behavior and reactions of organic pollutants in the environment. Biodegradation, bioavailability and bioaccumulation. Ecotoxicological effects at the molecular level. Aspects of chemical trace analysis.

#### Objective
- The students develop an understanding of the processes that govern the fate and effects of chemicals in the environment.  
- The students know a number of methods for estimating the fate and effect of environmental pollutants. They recognize the relevant processes affecting a given compound and know how to use appropriate estimation methods for their quantification.
Part I: Fate of Chemicals in the Environment:
Relevant environmental compartments and how chemicals reach the environment.
Partitioning in the environment:
- Meaning of vapor pressure, water solubility and air-water partition coefficient for environmental behavior
- Octanol-water partition coefficient as surrogate for partitioning into biological systems
- Influence of temperature and pH on partitioning
- Global distribution of semi-volatile chemicals
- Molecular interactions that govern partitioning
- Sorption to natural surfaces, partitioning into natural organic matter
Chemical and photochemical transformation reactions
Microbial transformation processes in the environment

Part II: Effects of chemicals in the environment
Biological test systems for assessing ecotoxicological effects
Endpoints of toxicity assessment:
- Acute and chronic toxicity, effects on reproduction
- Dose-response modeling
Bioavailability and bioaccumulation:
- Bioconcentration, biomagnification, food chain accumulation
- Active and passive uptake mechanisms
Molecular mechanisms of toxicity in cells:
- Baseline toxicity
- Specific toxicity (Examples: Inhibition of photosynthesis, neurotoxicity, including AchEsterase, ion channels etc.)
- Oxidative stress
- Genotoxicity

Part III: Specific aspects of trace analysis in the environment (soil, water, air)
Planning of analytical strategy and sampling
Enrichment procedures
Separation and detection
Quantification, screening for unknowns

Lecture notes
Copies of the slides and some articles are distributed

Literature

701-1233-00L
Stratospheric Chemistry
4 credits
2V+1U
T. Peter, A. Stenke

Abstract

Objective
The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect.

Content
Short presentation of thermodynamical and kinetic basics of chemical reactions: bi- and tere nero molar reactions, photo-dissociation. Introduction to the chemical family concept: active species, their source gases and reservoir gases. Detailed treatment of the pure oxygen family (odd oxygen) according to the Chapman chemistry. Radical reactions of the oxygen species with nitric oxide, active halogenes (chlorine and bromine) and odd hydrogen. Ozone depletion cycles. Methane depletion and ozone production in the lower stratosphere (photo-smog reactions). Heterogeneous chemistry on the background aerosol and its significance for heavy air traffic. Chemistry and dynamics of the ozone hole: Formation of polar stratospheric clouds and chlorine activation.

Lecture notes
Documents are provided in the contact hours.

Literature

Prerequisites / notice
Prerequisites: Basics in physical chemistry are required and an overview equivalent to the bachelor course in atmospheric chemistry (lecture 701-0471-01) is expected.

701-1233-00 V starts in the first week of the semester. The exercises 701-1233-00 U will start only in the 2nd week of the semester.

GESS Science in Perspective
see GESS Science in Perspective: Type A: Enhancement of Reflection Capability
see GESS Science in Perspective: Language Courses
ETH/IZH

Recommended GESS Science in Perspective (Type B) for D-CHAB.

Chemistry Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Q</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/labatory course</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<td>K</td>
<td>colloquium</td>
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### ECTS

- European Credit Transfer and Accumulation System
  - Special students and auditors need special permission from the lecturers.
Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Diploma Sport.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching concept following a goal set in advance.</td>
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<td></td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td>- Get information about recent literature on learning and instruction</td>
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<td><strong>Prerequisites / Notice</strong></td>
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<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner,</td>
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<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Diploma Sport.</td>
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<td>Number of participants limited to 30.</td>
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<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>B. Rütsche</td>
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<tr>
<td></td>
<td>The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<td><strong>Objective</strong></td>
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<td>- Understanding research methods used in the empirical human sciences</td>
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<td>- Getting to know intelligence tests</td>
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<td>- Understanding findings relevant for education</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche,</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>E. Stern, E. Ziegler</td>
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<tr>
<td></td>
<td>Literature from the learning sciences is critically discussed with a focus on research methods.</td>
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<td></td>
<td>At the first meeting, working groups will be assembled and meetings with those will be set up.</td>
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<tr>
<td></td>
<td>In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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<tr>
<td>851-0242-09L</td>
<td>Student Research Projects: Practical Research on Learning and Instruction</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>A. Deiglmayr, P. Edelsbrunner,</td>
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<td></td>
<td>Number of participants limited to 20.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>B. Rütsche, S. Hofer, B. Rütsche, L. Schalk, E. Stern, E. Ziegler</td>
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<tr>
<td></td>
<td>In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning &amp; Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)</td>
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<td></td>
<td>Learning goals include:</td>
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<td></td>
<td>- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.</td>
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<td>- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.</td>
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<td>- Participants can design and conduct a study that is relevant for answering their research question.</td>
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<td></td>
<td>- Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.</td>
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</tbody>
</table>

Subject Didactics in Chemistry

Important: You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
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<tr>
<td>529-0959-00L</td>
<td>Mentored Work Subject Didactics Chemistry</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>R. Ciocciaro</td>
</tr>
</tbody>
</table>

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 352 of 1571
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**

The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**

Thematische Schwerpunkte

Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen


Lecture notes

Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

**Literature**

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Prerequisites / notice

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

**529-0960-00L**

Mentored Work Subject Didactics Chemistry B

- Abstract
  
  In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

- Objective
  
  The objective is for the students:
  - to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
  - to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

- Content
  
  Thematische Schwerpunkte

  Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

  Lernformen


- Lecture notes

  Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

- Literature

  Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

- Prerequisites / notice

  Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

**529-0950-00L**

Subject Didactics Chemistry I

- Abstract

  Implementing findings from research into teaching and learning for chemistry lessons and coverage of subject-specific teaching and learning specialities.

- Objective

  Among other things, students are put in a position where they can:
  - divide up the subject matter into contents that can be learned by heart or accessed intellectually, and communicate these contents.
  - break down technically complex contents to the right level for a class and still present these in a stringent, error-free manner in their simplified form.
  - establish which subject matter can be presented with which teaching techniques and methods that have been recognised as efficient in teaching terms, and adapt these tools to the learning content in question.
  - plan school experiments, incorporate them in lessons, perform them in accordance with all the rules of the art, and also evaluate them in a simplified form.
  - reliably identify stumbling blocks in the contents and get round these.

- Content

  Schwerpunkte

  Im ersten Studiensemester bilden die folgenden Themen:

  - Auswahl gymnasiumsrelevanter Lerninhalte
  - Modellbegriff in den Naturwissenschaften, insbesondere der Chemie
  - Sprache und Fachsprache im Chemieunterricht
  - Wechselwirkungen zwischen Beobachtungen in der realen Welt und Deutungsversuchen auf der Modell-Ebene
  - Interdisziplinarität mit Biologie, Mathematik und Physik
  - Leistungserhebung und -beurteilung im Theorie- und Laborunterricht
  - Atommö modelle und chemische Bindung
  - Mathematische Beschreibung chemischer Systeme (z.B. Stöchiometrie und Gleichgewichtssysteme)
  - Auswahl, Konzeption, Einbettung, Vorbereitung, Durchführung, Nachbereitung und Auswertung von Demonstrations- und Schüler-Experimenten

- Lecture notes


- Literature

Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

Amongst other things, students are put in a position to observe the safety provisions, accompany pupils’ experiments from the content, pedagogical and safety angles, plan and implement the incorporation of experiments in their tuition, adapt experiments described in the literature to their own teaching situation, develop experiments of their own, and appreciate whether experiments would make sense, or are even indispensable. They learn to assess pupils’ work, they improve their subject-didactic skills and are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils. They acquire the skills of the teaching trade, they are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils. They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils. They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils. They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
Die Studierenden erfahren das Lektionsthema in der Regel eine Woche vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten sie Informationen über den Wissensstand der zu unterrichtenden Klasse und können sie vor dem Prüfungstermin besuchen. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortag um 12 Uhr den beiden Prüfungsexperten ein.

Die gehaltene Lektion wird kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/ der Kandidatin über die gehaltene Lektion im Rahmen eines kurzen Kolloquiums.

**529-0968-01L Examination Lesson I Chemistry**

Simultaneous enrolment in "Examination Lesson II Chemistry" (529-0968-02L) is compulsory.

**Abstract**

Will mark the conclusion of the teacher training program in Chemistry.

**Objective**

- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

**Content**


**Lecture notes**

Dokument: Schriftliche Vorbereitung für Prüfungslektionen: https://www.ethz.ch/content/dam/ethz/main/education/didaktische-ausbildung/Files/Diverses/schultliche%20Unterrichtsvorb%20%C3%Bcr%C3%BCfel%04.11.2014..pdf

**Prerequisites / notice**

Nach Abschluss der übrigen Ausbildung.

**529-0968-02L Examination Lesson II Chemistry**

Simultaneous enrolment in "Examination Lesson I Chemistry" (529-0968-01L) is compulsory.

**Abstract**

Will mark the conclusion of the teacher training program in Chemistry.

**Objective**

- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

**Content**


**Lecture notes**

Dokument: Schriftliche Vorbereitung für Prüfungslektionen: https://www.ethz.ch/content/dam/ethz/main/education/didaktische-ausbildung/Files/Diverses/schultliche%20Unterrichtsvorb%20%C3%Bcr%C3%BCfel%04.11.2014..pdf

**Prerequisites / notice**

Nach Abschluss der übrigen Ausbildung.


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0962-00L</td>
<td>Fundamental Aspects of Chemistry with an Educational Focus B</td>
<td>O</td>
<td>4</td>
<td>2V</td>
<td>A. Togni, R. Alberto</td>
</tr>
<tr>
<td></td>
<td>Mentored Work with an Educational Focus B for Teaching Diploma.</td>
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</tbody>
</table>

**Abstract**

Selected topics in general chemistry:
1) The language of chemistry
2) Chirality and stereochemistry
3) Oxidation of water
4) Chemistry of the atmosphere

**Objective**

In this course, participants acquire extended and more in-depth knowledge of selected chemistry topics. The selection is based to a large extent on the partial aspects of chemistry that are typically taught at high school. By gaining a broader understanding, teachers are put in a position where they can comprehend the topics that are to be taught in a wider and, to some extent, unconventional context and critically process these in respect of their teachability and learnability. At the same time, interrelationships between the classical sub-disciplines of chemistry are highlighted, along with the unique features of chemistry as one of the central natural sciences.

**Content**

Content of the four modules:
1) The language of chemistry: Concepts, formulas, aesthetics, and philosophical aspects
2) Chirality and stereochemistry: Selected aspects, origin of biomolecular chirality, inorganic chemistry
3) Cosmochemistry
4) Chemistry of the atmosphere

**Lecture notes**

Foli en ausgewählte Literatur werden zur Verfügung gestellt.

**Literature**

Ausgewählte Artikel aus der Primärliteratur werden vorgestellt, kommentiert und zur Lektüre empfohlen.

**Prerequisites / notice**

FV A (gelesen im Frühjahrssemester) und FV B (gelesen im Herbstsemester) bauen nicht aufeinander. Die Reihenfolge der Belegung ist somit indifferent.
Subject with an Educational Focus Chemistry B

Abstract
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective
The aim is for the students
- to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.
- to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership.
- To try out different options for specialist further training in their profession.

Content
Thematische Schwerpunkte:

Lernformen:

Lecture notes
Eine Anleitung zur mentorierten Arbeit in FV wird zur Verfügung gestellt.

Literature
Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Compulsory Elective Courses

see Compulsory Elective Courses Teaching Diploma

Additional Requirements (ETH-Masterstudents in Chemical + Bioeng.)

Part 1

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>529-0200-00L</td>
<td>Research Project I</td>
<td>O</td>
<td>16 credits</td>
<td>16A</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to try out an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student. Students are accustomed to scientific work and they get to know one specific research field.</td>
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<tr>
<td>Objective</td>
<td>Students are accustomed to scientific work and they get to know one specific research field.</td>
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<tr>
<td>529-0132-00L</td>
<td>Inorganic Chemistry III: Organometallic Chemistry and Homogeneous Catalysis</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Togni, A. Mezzetti</td>
</tr>
<tr>
<td>Abstract</td>
<td>Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbylation, C-C bond-forming and related reactions. Towards an understanding of the fundamental coordination-chemical and mechanistic aspects of transition-metal chemistry relevant to homogeneous catalysis.</td>
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<tr>
<td>Objective</td>
<td>Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbylation, C-C bond-forming and related reactions.</td>
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<td>Content</td>
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Advanced Methods and Strategies in Synthesis

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0241-00L</td>
<td>Advanced Methods and Strategies in Synthesis</td>
<td>O</td>
<td>7 credits</td>
<td>3G</td>
<td>J. W. Bode</td>
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<tr>
<td>Abstract</td>
<td>Advanced Modern Methods and Strategies in Synthesis</td>
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<tr>
<td>Objective</td>
<td>Knowledge of modern methods in asymmetric stereocentre, enantioselective catalysis, and organic reaction mechanisms. Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precendents, and emerging topics will be emphasized.</td>
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<tr>
<td>Content</td>
<td>Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precendents, and emerging topics will be emphasized.</td>
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<tr>
<td>Lecture notes</td>
<td>will be provided in class and online</td>
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Part 2

see Chemistry Master > Electives

Chemistry Teaching Diploma - Key for Type

<p>| O  | Compulsory | E- | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended | Z | Courses outside the curriculum |
| W  | Eligible for credits | Dr | Suitable for doctorate |</p>
<table>
<thead>
<tr>
<th>Key for Hours</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Advanced Modern Methods and Strategies in Synthesis

**Title:** Advanced Physical Chemistry: Statistical Thermodynamics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0433-00L</td>
<td>Inorganic and Organometallic Polymers</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>H. Grützmacher, J. Grützmacher</td>
</tr>
</tbody>
</table>

#### Objective
Understanding of the current literature in the field of inorganic polymers and materials.

#### Lecture notes
A manuscript will be distributed to the participants of the course.

#### Literature
Script and recent original literature indicated in the course.

#### Prerequisites / notice
Basis for the understanding of this lecture are the courses Allgemeine Chemie 1 & 2, Anorganische Chemie 1: Übergangsmetallichemie (Dozent Mezzetti).

### Organic Chemistry

#### Advanced Methods and Strategies in Synthesis

**Title:** Organic Synthesis: Methods and Strategies

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0241-00L</td>
<td>Advanced Methods and Strategies in Synthesis</td>
<td>W+</td>
<td>7 credits</td>
<td>3G</td>
<td>J. W. Bode</td>
</tr>
</tbody>
</table>

#### Objective
Knowledge of modern methods in asymmetric stereocontrol, enantioselective catalysis, and organic reaction mechanisms.

#### Content
Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precendents, and emerging topics will be emphasized.

#### Lecture notes
will be provided in class and online

#### Literature
Suggesting Textbooks
3. B. H. Meier, M. Ernstr, Inorganic and Organometallic Polymers, J. Grützmacher

### Physical Chemistry

#### Advanced Physical Chemistry: Statistical Thermodynamics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0343-00L</td>
<td>Advanced Magnetic Resonance</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>B. H. Meier, M. Ernst</td>
</tr>
</tbody>
</table>

#### Objective
The aim of the course is to familiarize the students with the basic concepts of magnetic resonance relaxation theory in liquids and solids. Starting from the mathematical description of spin dynamics, the effect of stochastic motional processes on the density operator will be analyzed. In the end students should understand the Redfield formulation of relaxation and be able to understand the effect of dynamics on magnetic resonance experiments.

#### Content
The aim of the course is to familiarize the students with the basic concepts of magnetic resonance relaxation theory in liquids and solids. Starting from the mathematical description of spin dynamics, the effect of stochastic motional processes on the density operator will be analyzed. In the end students should understand the Redfield formulation of relaxation and be able to understand the effect of dynamics on magnetic resonance experiments.

#### Lecture notes
A script which covers the topics will be distributed in the lecture and will be accessible through the web page http://www.ssnmr.ethz.ch/education/
Light interacts surprisingly differently with small particles than with bulk or with gas phase materials. The first part of the course provides a basic but rigorous introduction into the interaction of light with nano- and microparticles. The emphasis is on the classical treatment of absorption and scattering of light by small particles. The strengths and limits of this conventional approach will be discussed. The second part of the course is devoted to a broad range of applications. Here, topics include: Plasmon resonances in metallic systems, metallic dielectric nanoparticles for medical applications, the use of lasers for optical trapping and characterization of single particles, vibrational excitons in dielectric nanoparticles, interaction of light with aerosol particles and cloud droplets for remote sensing applications and climate predictions, characterization of ultrafine aerosol particles by photoemission using velocity mapping imaging.

Lecture notes will be distributed during the course.

Literature Basics: Absorption and Scattering of Light by Small Particles, C. F. Bohren and D. R. Huffman, John Wiley & Sons, Inc.

Applications: References will be provided during the course.

---

### Electives

#### Inorganic Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0143-00L</td>
<td>Inorganic and Organometallic Polymers</td>
<td>O</td>
<td>7 credits</td>
<td>3G</td>
<td>H. Grüutmacher, J. Grüutmacher</td>
</tr>
</tbody>
</table>

**Abstract**

This course provides an introduction to the interaction of light with nano- and microparticles followed by an overview of applications of current interest. Examples range from nanoparticles for medical applications and sensing to the role of the interaction of solar radiation with aerosol particles and cloud droplets for the climate.

**Objective**

The students will be introduced to the basic concepts of the interaction of light with nano- and microparticles. The combination of basic concepts with different applications will enable students to apply their knowledge to new problems in various fields where nanoscale objects play a role.

**Content**

Light interacts surprisingly differently with small particles than with bulk or with gas phase materials. The first part of the course provides a basic but rigorous introduction into the interaction of light with nano- and microparticles. The emphasis is on the classical treatment of absorption and scattering of light by small particles. The strengths and limits of this conventional approach will be discussed. The second part of the course is devoted to a broad range of applications. Here, topics include: Plasmon resonances in metallic systems, metallic dielectric nanoparticles for medical applications, the use of lasers for optical trapping and characterization of single particles, vibrational excitons in dielectric nanoparticles, interaction of light with aerosol particles and cloud droplets for remote sensing applications and climate predictions, characterization of ultrafine aerosol particles by photoemission using velocity mapping imaging.

Lecture notes will be distributed during the course.

Literature Basics: Absorption and Scattering of Light by Small Particles, C. F. Bohren and D. R. Huffman, John Wiley & Sons, Inc.

Applications: References will be provided during the course.

#### Organic Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0243-00L</td>
<td>Reactive Intermediates</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>P. Chen</td>
</tr>
</tbody>
</table>

**Abstract**

Advanced physical organic chemistry. Methods for the elucidation of reaction mechanisms. Reactive intermediates. Thermochemistry; isolation labeling; cross-over experiments; kinetic isotope effects; thermodynamics-kinetics correlations; solvation and ion pairs; radical reactions; electron transfer; spectroscopic methods.

**Objective**

Methods for the elucidation of organic reaction mechanisms.

**Content**


**Lecture notes**

A printed script are handed out in the course. This material is also available for download from the web page of the course (as pdf files).

**Literature**

Additional reading and original publications are cited in the lectures.

**Prerequisites / notice**

Required level: Courses in organic and physical chemistry of the first and second year. Each participant is expected to contribute to a 30 min. seminar (prepared by groups of 2-4 students), presented in the last weeks of the semester.

#### Physical Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0241-00L</td>
<td>Advanced Methods and Strategies in Synthesis</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>J. W. Bode</td>
</tr>
</tbody>
</table>

**Abstract**

Advanced Modern Methods and Strategies in Synthesis

**Objective**

Knowledge of modern methods in asymmetric stereoccontrol, enantioselective catalysis, and organic reaction mechanisms.

**Content**

Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precedents, and emerging topics will be emphasized.

**Prerequisites / notice**

will be provided in class and online

**Literature**

Suggesting Textbooks

### Physical Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0233-00L</td>
<td>Organic Synthesis: Methods and Strategies</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>E. M. Carreira</td>
</tr>
</tbody>
</table>

**Abstract**

The complex relation between structural analysis, methods leading to desired transformations, and insight into reaction mechanisms is exemplified. Relations between retrosynthetic analysis of target structures, synthetic methods and their combination in a synthetic strategy.

**Objective**

Extension and deepening of the knowledge in organic synthesis.

**Content**


**Literature**


**Prerequisites / notice**

OC I-IV
The course is for advanced students and covers selected topics from magnetic resonance spectroscopy. This year, the lecture will introduce and discuss relaxation theory and its applications in magnetic resonance.

The aim of the course is to familiarize the students with the basic concepts of magnetic resonance relaxation theory in liquids and solids. Starting from the mathematical description of spin dynamics, the effect of stochastic motional processes on the density operator will be analyzed. In the end, students should understand the Redfield formulation of relaxation and be able to understand the effect of dynamics on magnetic resonance experiments.

The aim of the course is to familiarize the students with the basic concepts of magnetic resonance relaxation theory in liquids and solids. Starting from the mathematical description of spin dynamics, the effect of stochastic motional processes on the density operator will be analyzed. In the end, students should understand the Redfield formulation of relaxation and be able to understand the effect of dynamics on magnetic resonance experiments.

A script which covers the topics will be distributed in the lecture and will be accessible through the web page http://www.ssnmr.ethz.ch/education/

This course provides an introduction to the interaction of light with nano- and microparticles followed by an overview of applications of current interest. Examples range from nanoparticle applications for medical and sensing to the role of the interaction of solar radiation with aerosol particles and cloud droplets for the climate.

The students will be introduced to the basic concepts of the interaction of light with nano- and microparticles. The combination of basic concepts with different applications will enable students to apply their knowledge to new problems in various fields where nanoscale objects play a role.

Light interacts surprisingly differently with small particles than with bulk or gas phase materials. The first part of the course provides a basic but rigorous introduction into the interaction of light with nano- and microparticles. The emphasis is on the classical treatment of absorption and scattering of light by small particles. The strengths and limits of this conventional approach will be discussed. The second part of the course is devoted to a broad range of applications. Here, topics include: Plasmon resonances in metallic systems, metallo-dielectric nanoparticles for medical applications, the use of lasers for optical trapping and characterization of single particles, vibrational excitons in dielectric nanoparticles, interaction of light with aerosol particles and cloud droplets for remote sensing applications and climate predictions, characterization of airborne aerosol particles by photoemission using velocity map imaging.

**Analytical Chemistry**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0043-00L</td>
<td>Analytical Strategy</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>R. Zenobi, R. Signorell</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Ability to create solutions for particular analytical problems.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Individual development of strategies for the optimal application of chemical, biochemical, and physico-chemical methods in analytical chemistry solving predefined problems. Experts from industry and administration present particular problems in their field of activity. Principles of sampling. Design and application of microanalytical systems.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>Copies of problem sets and solutions will be distributed free of charge.</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>529-0051-00 &quot;Analytical Chemistry I (3. Semester)*</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>529-0058-00 &quot;Analytical Chemistry II (4. Semester)* (or equivalent)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0049-00L</td>
<td>Analytical Methods for Characterization of Nanoparticles and Nanomaterials</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>C. Latkoczy</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Introduction to modern analytical methods used to fully characterize and identify nano-engineered materials and systems.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Understanding of analytical concepts used in nanotechnology. In-depth knowledge of most important methods used in industry and research. Introduction to selected industrial applications. Basic knowledge of production mechanisms of nano-engineered materials.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Nanotechnology is the basis of many main technological innovations of the 21st century. After more than twenty years of research, nanotechnologies are now increasingly employed for commercial use: they are used in hundreds of everyday consumer products, such as cosmetics, food, automotive, electronics and medical products. Nanoparticles can contribute to stronger, lighter, cleaner, smarter, better, etc. products. Besides these positive effects, relatively little is still known about potential health and environmental effects and risks of such small nano-sized particles. Therefore, a lot of different industry customers are forced nowadays to monitor and regulate the size and concentration of nanoparticles in their nano-enabled products. Above and beyond these regulatory requirements, most industries employing nanoparticles need to be able to online measure nanoparticles to meet their requirements towards quality control and production efficiency. All these requirements demand new precise, accurate, fast and innovative analysis methods to fully characterize nanoparticles in real-time and during the manufacturing process.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>Lecture notes will be provided</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>Prerequisites: 529-0051-00 &quot;Analytical Chemistry I (3. Semester)<em>, 529-0058-00 &quot;Analytical Chemistry II (4. Semester)</em> (or equivalent)</td>
</tr>
</tbody>
</table>

**Biological Chemistry**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0733-00L</td>
<td>Enzymes</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>D. Hilvert</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>A script will not be handed out.</td>
</tr>
</tbody>
</table>
General:

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

529-0735-00L Chemical Aspects of Diffraction and Instrumentation, Unit Cells, Lattices, and Symmetry. Inorganic Structural Chemistry: Sphere Packings

Lecture notes

Abstract
This course will introduce basic concepts of fluorescence spectroscopy and microscopy applied to the observation and manipulation of biological systems. The course will focus on the design, preparation and implementation of small-molecule and protein-based probes for biological investigations.

Objective
To understand the basic chemical aspects of bioimaging and photoactivation in biology.

Content
Principles of fluorescence spectroscopy and microscopy, fluorescent dyes and proteins, chemiluminescence, super-resolution microscopy, fluorescent sensors, photoremovable groups, photoswitchable molecules, and optogenetics.

Handouts, selected original literature, problem sets, and other materials will be provided electronically.


529-0735-00L Chemical Aspects of Bioimaging

W 7 credits 2V+1U P. Rivera Fuentes

A. Wokaun
N. Trapp

Autumn Semester 2016

Data: 06.11.2018 12:57

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**Chemical Technology**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>636-0003-00L</td>
<td>Biological Engineering and Biotechnology</td>
<td>W</td>
<td>6</td>
<td>3V</td>
<td>M. Fussenegger</td>
</tr>
</tbody>
</table>

**Abstract**

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

**Objective**

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to The Clinics.
6. Biology and Malign Applications. Do Life Sciences Enable the Development of Biological Weapons?
7. Functional Food. Enjoy your Meal!

**Lecture notes**

Handout during the course.

**HOURS**

- **Title**: Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
- **Lecturer**: M. Reiher

**Additional references**


**Prerequisites / notice**

Students will conduct the computational exercises and examples of structure solution and refinement on personal computers.

**Prerequisite**: Principles of Crystal Structure Determination (529-0039-00L).

**Computational Chemistry**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0003-00L</td>
<td>Advanced Quantum Chemistry</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>M. Reiher, S. Knecht</td>
</tr>
</tbody>
</table>

**Abstract**

Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems with a computer. Examples are:

- Operators derived from principles of relativistic quantum mechanics
- Relativistic effects + methods of relativistic quantum chemistry
- Open-shell molecules + spin-density functional theory
- New electron-correlation theories

**Objective**

The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that this is necessary in order to be able to solve actual chemical problems on a computer with quantum chemical methods.

**Content**

- 1) Introductory lecture: basics of quantum mechanics and quantum chemistry
- 2) Einstein's special theory of relativity and the (classical) electromagnetic interaction of two charged particles
- 3) Klein-Gordon and Dirac equation; the Dirac hydrogen atom
- 4) Numerical methods based on the Dirac-Fock-Coulomb Hamiltonian, two-component and scalar relativistic Hamiltonians
- 5) Response theory and molecular properties, derivation of property operators, Breit-Pauli-Hamiltonian
- 6) Relativistic effects in chemistry and the emergence of spin
- 7) Spin in density functional theory
- 8) New electron-correlation theories: Tensor network and matrix product states, the density matrix renormalization group
- 9) Quantum chemistry without the Born-Oppenheimer approximation

**Lecture notes**

A set of detailed lecture notes will be provided, which will cover the whole course.
Prerequisites / notice

529-0004-00L Computer Simulation in Chemistry, Biology and Physics

Abstract

Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

For more information: www.csms.ethz.ch/education/CSCBP

Objective

Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content

Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Lecture notes

Available (copies of powerpoint slides distributed before each lecture)

Literature

See: www.csms.ethz.ch/education/CSCBP

Prerequisites / notice

Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/CSCBP

Materials Science

course: Introduction to Macromolecular Chemistry (529-0941-00L) will be given in spring semester

Environmental Chemistry

Number Title Type ECTS Hours Lecturers
529-0745-00L General and Environmental Toxicology W 7 credits 3V M. Arand, K. Hungerbühler, H. Nägeli, B. B. Stieber, I. Werner

Abstract

Toxicokinetic and toxicodynamic aspects of xenobiotic interactions with cellular structures and mechanisms. Toxic responses at the level of organs (immune-, neuro-, reproductive and genotoxicity) and organisms. Introduction into developmental toxicology and ecotoxicology.

Objective

Explanation of important interactions between xenobiotic chemicals and cellular structures such as membranes, enzymes, and nucleic acids. Relevance of intake, distribution, excretion, and biochemical transformation processes. Relevance of mixtures. Explanation of important modes of toxic action such as immuno toxicity, neurotoxicity, reproduction toxicity, genotoxicity based on examples of certain xenobiotics and their effects on important organs.

Lecture notes

Course material will be handed out as the lectures progress

Literature

Textbooks of pharmacology and toxicology (cf. list in course material)

Prerequisites / notice

Educational basis: basic chemistry, biology and biochemistry

529-0047-00L Risk Assessment of Chemicals W 7 credits 6A C. Bogdal, K. Hungerbühler, N. von Götz, Z. Wang

Abstract

Projects on chemical assessment with the focus on the analysis and assessment of basic substance data for selected chemical classes; analysis and modelling of technical processes; characterisation of environmental and health risks. Risk assessment on the basis of quality and protection goals. Estimation of model and parameter uncertainty. Precaution and safety measures.
Objective

Projects on chemical assessment with the focus on the following aspects:

- Analysis and assessment of basic substance data for selected chemical classes: physical chemical properties, environmental behaviour (distribution, persistence), and human and eco-toxicity (biochemical metabolism, effect mechanisms), safety.
- Analysis and modelling of technical processes determining chemical release into the environment, e.g., chemicals applications.
- Characterisation of environmental and health risks on the basis of exposure and effect models, QSARs from environmental chemistry, toxicology and methods of risk analysis.
- Risk assessment on the basis of quality and safety goals. Estimation of the model and data uncertainty.
- Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

Content

Project thesis (report) on chemicals assessment; time frame totals ca. 80 hours.

Lecture notes

Project teaching; time frame totals ca. 80 hours.

Literature

See recommended literature:


Prerequisites / notice

Voraussetzung:

529-0580-00L - Risikoanalyse chemischer Prozesse und Produkte
oder: 701-0998-00L - Environmental and Human Health Risk Assessment of Chemicals

Beschränkt auf 6 Projektarbeiten pro Semester

Laboratory Courses and Research Projects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0200-00L</td>
<td>Research Project I</td>
<td>O</td>
<td>16</td>
<td>16A</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Students are accustomed to scientific work and they get to know one specific research field.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>529-0201-00L</td>
<td>Research Project II</td>
<td>O</td>
<td>17</td>
<td>17A</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Students are accustomed to scientific work and they get to know one specific research field.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>529-0739-00L</td>
<td>Biological Chemistry A: Technologies for Directed Evolution of Enzymes</td>
<td>W</td>
<td>16</td>
<td>16P</td>
<td>P. A. Kast, D. Hilvert</td>
</tr>
<tr>
<td>Abstract</td>
<td>Limited number of participants.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>During this semester course, methodologies will be taught for biological-chemical enzyme evolution experiments using molecular genetic mutation technologies and in vivo selection in recombinant bacterial strains.</td>
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</tr>
<tr>
<td>Content</td>
<td>All technologies used for the experiments will be explained to the students in practice with the goal that they will be able to independently apply them for the course project and in future research endeavors. After the course, an individual report about the results obtained has to be prepared.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>This class conducts and supports experiments for a specifically designed genuine research project. We will carry out biological-chemical enzyme evolution experiments using molecular genetic mutation technologies and in vivo selection in recombinant bacterial strains. The relevant technologies will be taught to the students, such as the preparation of competent cells, production and isolation of DNA fragments, transformation of gene libraries, and DNA sequencing. The course participants will generate a variety of different variants of a chorismate mutase. Individual enzyme catalysts will be purified and subsequently characterized using several different spectroscopic methods. The detailed chemical-physical analyses include determination of the enzymes' kinetic parameters, their molecular mass, and the integrity of the protein structure. The students will present the results obtained from their individual evolution experiments at the end of the semester. We expect that during this lab course we will not only generate novel enzymes, but also gain new mechanistic insights into the investigated catalyst.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Further information to registration and work hours: <a href="http://www.protein.ethz.ch/kast/praktikum.html">www.protein.ethz.ch/kast/praktikum.html</a></td>
<td></td>
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</tbody>
</table>

Further literature will be indicated in the distributed script.

- Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 364 of 1571
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in

4. A. Mezzetti, R. Zenobi, Symmetry aspects of chemical bonding, point groups and representations for the deduction of molecular orbitals, energy assessment for molecules and translation polymers.

Objective
In the Master thesis students prove their ability to independent, structured and scientific working.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0051-AAL</td>
<td>Analytical Chemistry I</td>
<td>E-</td>
<td>3 credits</td>
<td>6R</td>
<td>D. Günther, R. Zenobi</td>
</tr>
<tr>
<td>529-0122-AAL</td>
<td>Inorganic Chemistry II</td>
<td>E-</td>
<td>3 credits</td>
<td>6R</td>
<td>M. Kovalenko</td>
</tr>
<tr>
<td>529-0132-AAL</td>
<td>Inorganic Chemistry III: Organometallic Chemistry and E-Homogeneous Catalysis</td>
<td></td>
<td>4 credits</td>
<td>9R</td>
<td>A. Togni, A. Mezzetti</td>
</tr>
</tbody>
</table>

Course 529-0289-00: "Instrumental analysis of organic compounds" (4th semester) is recommended.
Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbynylation, C-C bond-forming and related reactions.

Towards an understanding of the fundamental coordination-chemical and mechanistic aspects of transition-metal chemistry relevant to homogeneous catalysis.

Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbynylation, C-C bond-forming and related reactions.


**Chemistry Master - Key for Type**

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

**Key for Hours**

| V    | lecture         | P   | practical/laboratory course |
| G    | lecture with exercise | A   | independent project |
| U    | exercise        | D   | diploma thesis |
| S    | seminar         | R   | revision course / private study |
| K    | colloquium      |     |                          |

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Chemical and Bioengineering Master

#### Core Subjects

#### Bioengineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0837-00L</td>
<td>Biomicrofluidic Engineering</td>
<td>W+</td>
<td>3G</td>
<td>7 credits</td>
<td>A. de Mello</td>
</tr>
</tbody>
</table>

**Abstract**

Microfluidics describes the behaviour, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

**Objective**

In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern-day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale. The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.

**Content**

Specific topics in the course include, but not limited to:

1. Theoretical Concepts
2. Features of mass and thermal transport on the microscale
3. Key scaling laws
4. Microfluidic Device Manufacture
5. Conventional lithographic processing of rigid materials
6. Soft lithographic processing of plastics and polymers
7. Mass fabrication of polymeric devices
8. Unit operations and functional components
9. Analytical separations (electrophoresis and chromatography)
10. Chemical and biological synthesis
11. Sample pre-treatment (filtration, SPE, pre-concentration)
12. Molecular detection
13. Design Workshop
14. Design of microfluidic architectures for PCR, distillation & mixing
15. Contemporary Applications in Biological Analysis
16. Microarrays
17. Cellular analyses (single cells, enzymatic assays, cell sorting)
18. Proteomics
19. System integration
20. Applications in radiochemistry, diagnostics and high-throughput experimentation

**Lecture notes**

Lecture handouts, background literature, problem sheets and notes will be provided electronically.

#### Polymers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0615-00L</td>
<td>Polymerization Reaction and Colloid Engineering</td>
<td>W+</td>
<td>3G</td>
<td>7 credits</td>
<td>M. Morbidelli, P. Arosio</td>
</tr>
</tbody>
</table>

**Abstract**


**Objective**

Introduce the students to the design of polymerization reactors for the production of polymers with molecular characteristics suitably tuned for specific applications. This includes the post-treatment of polymer latexes and the analysis of their colloidal behavior.

**Content**

The aim of the course is to provide the tools needed for the understanding of the fundamental processes and the design of the industrial units involved in the production of polymeric materials and in the post-treatment of polymer colloids. In particular, the following topics are discussed: Physico-chemical characterization of polymers and description of the polymerization processes. Kinetics of free-radical polymerization and use of population balance models. Production of homo- and co-polymers with controlled characteristics in terms of molecular weight distribution and chain composition distribution. Living polymerizations. Design of polymerization reactors and the thermal runaway problem. Kinetics and control of emulsion polymerization. The radical segregation problem. Surfactants and colloidal stability. Aggregation kinetics and aggregate structure in conditions of diffusion and reaction limited aggregation. The role of shear conditions on aggregation and breakage kinetics and on the aggregate structure. Modeling and design of colloid aggregation processes.

**Lecture notes**

Skripts are available on the "Polymerization Reaction and Colloid Engineering" web page of the Morbidelli-group, vide the given link for details.

**Literature**


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0619-00L</td>
<td>Chemical Product Design</td>
<td>W+</td>
<td>3G</td>
<td>7 credits</td>
<td>W. J. Stark</td>
</tr>
</tbody>
</table>

**Abstract**

The 'Chemical Product Design' course teaches students quantitative concepts to analyze, select and transform theoretical concepts from chemistry and engineering into valuable real-world products. Basic chemistry and chemical engineering knowledge is required (Diffusion, Thermodynamics, Kinetics, ...).

**Objective**

This course starts with analyzing existing chemical needs and unmet technical challenges. We then develop the skills to critically analyze a specific chemical idea for a product, to rapidly test feasibility or chance for success and to eventually realize its manufacturing. The chemical engineering basics are then used to assess performance of products or devices with non-traditional functions based on dynamic properties (e.g., responsive building materials; personal medical diagnostics on paper strips). The course teaches the interface between laboratory and market with a specific focus on evaluating the chemical value of a given process or compound, and the necessary steps to pursue the resulting project within an entrepreneurial environment. We therefore extend the questions of process design (‘how do we make something?’) to the question of ‘what should we make?’
The 'Chemical Product Design' course starts with discussing questions along, 'What is a chemical product, and why do people pay for it? How does a given compound in a specific setting provide a service?' We then learn how to translate new, often ill-defined wishes or ideas into quantifiable specifications.

Part B: Thermodynamic and kinetic data allow sharp selection criteria for successful products. We learn how to deal with insufficient data and development of robust case models to evaluate their technical and financial constraints. How can parameters of a running process in one industry be scaled into another industry? Can dimensionless engineering numbers be applied beyond traditional chemical processes?

Part C: Manufacturing of commodity products, devices and molecular products: Chemical reactors, separation and detection or isolation units as part of a toolbox. Planning of manufacturing and decisions based on hard data. Providing quantitative answers on potential value generated.

Students are expected to actively develop chemical products along the course. Contributions will be made individually, or in small groups, where a larger topic is studied.

Commercial software packages are presented as a key engineering tool for solving process flowsheeting and simulation problems. An exemplary literature list is provided below:

**Overview of process simulation and flowsheeting**

**Process Design**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0613-00L</td>
<td>Process Simulation and Flowsheeting</td>
<td>W+</td>
<td>7 credits</td>
<td>3G</td>
<td>E. Capón García, K. Hungerbühler</td>
</tr>
</tbody>
</table>

**Abstract**
This course encompasses the theoretical principles of chemical process simulation, as well as its practical application in process analysis and optimization. The techniques for simulating stationary and dynamic processes are presented, and illustrated with case studies. Students are expected to actively develop chemical products along the course. Contributions will be made individually, or in small groups, where a larger topic is studied.

Commercial software packages are presented as a key engineering tool for solving process flowsheeting and simulation problems. An exemplary literature list is provided below:

**Objective**
This course aims to develop the competency of chemical engineers in process flowsheeting and simulation. Specifically, students will develop the following skills:
- Deep understanding of chemical engineering fundamentals: the acquisition of new concepts and the application of previous knowledge in the area of chemical process systems and their mechanisms are crucial to intelligently simulate and evaluate processes.
- Modeling of general chemical processes and systems: students have to be able to identify the boundaries of the system to be studied and develop the set of relevant mathematical relations, which describe the process behavior.
- Mathematical reasoning and computational skills: the familiarization with mathematical algorithms and computational tools is essential to be capable of achieving rapid and reliable solutions to simulation and optimization problems. Hence, students will learn the mathematical principles necessary for process simulation and optimization, as well as the structure and application of process simulation software. Thus, they will be able develop criteria to correctly use commercial software packages and critically evaluate their results.

**Content**
Overview of process simulation and flowsheeting
- Definition and fundamentals
- Classification: stationary (steady-state) versus dynamic (transient state) systems
- Fields of application
- Case studies

**Process modeling**
- Modeling strategies of process systems
- Mass conservation
- Energy conservation
- Species balance
- Momentum balance
- Multiphase-systems: equilibrium & non-equilibrium models
- Process system model

**Process simulation**
- Process specification
- Introduction to process specification
- Classification of mathematical models: AMS, DOE, DAE, PDE
- Model validation
- Software tools
- Solution methods for process flowsheeting
- Simultaneous methods
- Sequential methods
- Dynamic simulation
- Numerical solution: explicit and implicit methods
- Continuous-discrete simulation: handling of discontinuities

**Process optimization and analysis**
- Classification of optimization problems
- Linear programming
- Non-linear programming
- Dynamic programming
- Optimization methods in process flowsheeting
- Sequential methods
- Simultaneous methods

**Commercial software for simulation: Aspen Plus**
- Thermodynamic property methods
- Reaction and reactors
- Separation / columns
- Convergence & debugging

**Literature**
An exemplary literature list is provided below:

**Prerequisites / notice**
A basic understanding of material and energy balances, thermodynamic property methods and typical unit operations (e.g., reactors, flash separations, distillation/absorption columns etc.) is required.
The course aims at illustrating, from conception to implementation, the design of sustainable catalytic processes by integration of the principles of surface science, material science and catalysis. The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.


Process economic evaluation: equipment sizing and costing, time value of money, cash flow calculations.

Detailed Process Design: unit operation models, flash solution algorithms (different iterative methods, inside-out method), sequencing of nonideal distillation columns, networks of chemical reactors.

Lecture notes

no script

Literature


Prerequisites / notice

Prerequisite: Thermal Unit Operations

### Catalysis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0611-00L</td>
<td>Characterization of Catalysts and Surfaces</td>
<td>W+</td>
<td>7</td>
<td>3G</td>
<td>J. A. van Bokhoven, D. Ferri</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic elements of surface science important for materials and catalysis research. Physical and chemical methods important for research in surface science, material science and catalysis and their application is demonstrated on practical examples.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Objective</td>
<td>Basic aspects of surface science. Understanding of principles of most important experimental methods used in research concerned with surface science, material science and catalysis.</td>
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<tr>
<td>Content</td>
<td>Methods which are covered embrace: Gas adsorption and surface area analysis, IR-Spectroscopy, X-ray diffraction, X-ray photoelectron spectroscopy, X-ray absorption, solid state NMR, Electron Microscopy and others.</td>
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<table>
<thead>
<tr>
<th>Number</th>
<th>Catalysis Engineering</th>
<th>W+</th>
<th>7</th>
<th>3G</th>
<th>J. Pérez-Ramírez</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The purpose of the &quot;Catalysis Engineering&quot; course is to provide students with tools that enable the optimal design of catalytic materials and reactor engineering concepts favoring more sustainable manufacturing processes within the chemical industry.</td>
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<tr>
<td>Objective</td>
<td>The course aims at illustrating, from conception to implementation, the design of sustainable catalytic processes by integration of the principles of surface science, material science and catalysis. The word &quot;sustainable&quot; implies intensified processes with an improved exploitation of raw materials, wider use of renewable feedstocks, reduction of energy consumption, and minimized environmental impact.</td>
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<tr>
<td>Content</td>
<td>The following general aspects:</td>
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<tr>
<td></td>
<td>- Catalyst preparation and characterization</td>
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<td></td>
<td>- Kinetics</td>
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<tr>
<td></td>
<td>- Mass and heat transport</td>
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<td></td>
<td>- Selectivity</td>
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<td></td>
<td>- Deactivation</td>
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<tr>
<td></td>
<td>will be demonstrated for modern catalytic materials and processes of industrial relevance such as:</td>
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<td></td>
<td>- Chlorine recycling</td>
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<td></td>
<td>- NOx abatement</td>
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<tr>
<td></td>
<td>- Chemoselective hydrogenations</td>
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<tr>
<td></td>
<td>- Hierarchical zeolite catalysts</td>
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<td></td>
<td>- Syngas conversion</td>
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<td></td>
<td>- Biomass to chemicals and fuels</td>
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</tbody>
</table>

Lecture notes

The course material is based on an own script, journal articles, and slides.

Prerequisites / notice

It is assumed that students selecting this course are familiar with general concepts of catalysis, reactor design, and transport phenomena.

### Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Applied Fluid Dynamics</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0113-00L</td>
<td>Applied Fluid Dynamics</td>
<td>W</td>
<td>4</td>
<td>2+1U</td>
<td>J.P. Kunsch</td>
</tr>
<tr>
<td>Abstract</td>
<td>The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment. Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).</td>
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<tr>
<td>Objective</td>
<td>Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples.</td>
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</tr>
<tr>
<td>Content</td>
<td>Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water. There are many possible forms that the resulting damage may take, including fire and explosion when flammable substances are mixed. The topics covered include: Emissions, Liquids and gases from containers and pipelines, evaporation from pools and vaporization of gases kept under pressure, the spread and dilution of waste gas plumes in the wind, deflagration and detonation of inflammable gases, fires, explosions in gas-powered engines, pollution and exhaust gases in tunnels (tunnel fires etc.).</td>
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</tbody>
</table>

Lecture notes

not available

Prerequisites / notice

Requirements: successful attendance at lectures "Fluidodynamik I und II", "Thermodynamik I und II"
151-0190-00L  
**Turbulent Flows**  
W 4 credits 2V+1U  
P. Jenny

**Abstract**  
Contents  
- Laminar and turbulent flows, instability and origin of turbulence - Statistical description: averaging, turbulent energy, dissipation, closure problem - Scalings. Homogeneous isotropic turbulence, correlations, Fourier representation, energy spectrum - Free turbulence: wake, jet, mixing layer - Wall turbulence: Channel and boundary layer - Computation and modelling of turbulent flows

**Objective**  
Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation and elements of turbulence modelling

**Content**  
- Properties of laminar, transitional and turbulent flows.  
- Origin and control of turbulence. Instability and transition.  
- Statistical description, averaging, equations for mean and fluctuating quantities, closure problem.  
- Scalings, homogeneous isotropic turbulence, energy spectrum.  
- Turbulent free shear flows. Jet, wake, mixing layer.  
- Wall-bounded turbulent flows.  
- Turbulent flow computation and modeling.

**Lecture notes**  
Lecture notes are available

**Literature**  

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151-0951-00L  
**Process Design and Safety**  
W 4 credits 2V+1U  
P. Rudolf von Rohr

**Abstract**  
Process design and safety deals with the fundamentals of process apparatus, plant design and safety.

**Objective**  
The goal of the lecture is to expound design characteristics of systems for process engineering applications.

**Content**  
Fundamentals of plant and apparatus design; materials in the process industries, mechanical design and design rules of main components; pumps and fans; piping and armatures, safety in process industry

**Lecture notes**  
Script is available, English slides will be distributed

**Literature**  

---

151-0927-00L  
**Rate-Controlled Separations in Fine Chemistry**  
W 4 credits 3G  
M. Mazzotti

**Abstract**  
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

**Objective**  
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

**Content**  
The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

**Lecture notes**  
Handouts during the class

**Literature**  
Recommendations for text books will be covered in the class

**Prerequisites / notice**  
Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

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529-0611-00L  
**Characterization of Catalysts and Surfaces**  
W 7 credits 3G  
J. A. van Bokhoven, D. Ferri

**Abstract**  
Basic elements of surface science important for materials and catalysis research. Physical and chemical methods important for research in surface science, material science and catalysis are considered and their application is demonstrated on practical examples.

**Objective**  
Basic aspects of surface science. Understanding of principles of most important experimental methods used in research concerned with surface science, material science and catalysis.

**Content**  
Methods which are covered embrace: Gas adsorption and surface area analysis, IR-Spectroscopy, X-ray diffraction, X-ray photoelectron spectroscopy, X-ray absorption, solid state NMR, Electron Microscopy and others.

---

529-0615-00L  
**Polymerization Reaction and Colloid Engineering**  
W 7 credits 3G  
M. Morbidelli, P. Arosio

**Abstract**  

**Objective**  
Introduce the students to the design of polymerization reactors for the production of polymers with molecular characteristics suitably tuned for specific applications. This includes the post-treatment of polymer latexes and the thermal runaway problem. Kinetics and control of emulsion polymerization. The radical segregation problem. Surfactants and colloidal stability. Aggregation kinetics and aggregate structure in conditions of diffusion and reaction limited aggregation. The role of shear conditions on aggregation and breakage kinetics and on the aggregate structure. Modeling and design of colloid aggregation processes.

**Content**  
The aim of the course is to provide the tools needed for the understanding of the fundamental processes and the design of the industrial units involved in the production of polymeric materials and in the post-treatment of polymer colloids. In particular, the following topics are discussed: Physico-chemical characterization of polymers and description of the polymerization processes. Kinetics of free-radical polymerization and use of population balance models. Production of homo- and co-polymers with controlled characteristics in terms of molecular weight distribution and chain composition distribution. Living polymerizations. Design of polymerization reactors and the thermal runaway problem. Kinetics and control of emulsion polymerization. The radical segregation problem. Surfactants and colloidal stability. Aggregation kinetics and aggregate structure in conditions of diffusion and reaction limited aggregation. The role of shear conditions on aggregation and breakage kinetics and on the aggregate structure. Modeling and design of colloid aggregation processes.

**Lecture notes**  
Scripts are available on the 'Polymerization Reaction and Colloid Engineering' web page of the Morbidelli-group, vide the given link for details.

**Literature**  

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529-0613-00L  
**Process Simulation and Flowsheeting**  
W 7 credits 3G  
E. Capón Garcia, K. Hungerbühler

**Abstract**  
This course encompasses the theoretical principles of chemical process simulation, as well as its practical application in process analysis and optimization. The techniques for simulating stationary and dynamic processes are presented, and illustrated with case studies.

**Objective**  
Commercial software packages are presented as a key engineering tool for solving process flowsheeting and simulation problems.

**Content**  
- Deep understanding of chemical engineering fundamentals: the acquisition of new concepts and the application of previous knowledge in the area of chemical process systems and their mechanisms are crucial to intelligently simulate and evaluate processes.  
- Modeling of general chemical processes and systems: students have to be able to identify the boundaries of the system to be studied and develop the set of relevant mathematical relations, which describe the process behavior.  
- Mathematical reasoning and computational skills: the familiarization with mathematical algorithms and computational tools is essential to be capable of achieving rapid and reliable solutions to simulation and optimization problems. Hence, students will learn the mathematical principles necessary for process simulation and optimization, as well as the structure and application of process simulation software. Thus, they will be able develop criteria to correctly use commercial software packages and critically evaluate their results.
The 'Chemical Product Design' course teaches students quantitative concepts to analyze, select and transform theoretical concepts from process simulation and flowsheeting.

### Content
- Overview of process simulation and flowsheeting
  - Definition and fundamentals
  - Classification: stationary (steady-state) versus dynamic (transient state) systems
  - Fields of application
  - Case studies
- Process modeling
  - Modeling strategies of process systems
  - Mass conservation
  - Species balance
  - Energy conservation
  - Momentum balance
  - Multiphase-systems: equilibrium & non-equilibrium models
  - Process system model
- Process simulation
  - Process specification
  - Introduction to process specification
  - Classification of mathematical models: AMS, DOE, DAE, PDE
  - Model validation
  - Simulation tools
  - Solution methods for process flowsheeting
  - Simultaneous methods
  - Sequential methods
  - Dynamic simulation
  - Numerical solution: explicit and implicit methods
  - Continuous-discrete simulation: handling of discontinuities
- Process optimization and analysis
  - Classification of optimization problems
  - Linear programming
  - Non-linear programming
  - Dynamic programming
  - Optimization methods in process flowsheeting
  - Sequential methods
  - Simultaneous methods

### Literature
An exemplary literature list is provided below:

### Prerequisites / notice
A basic understanding of material and energy balances, thermodynamic property methods and typical unit operations (e.g., reactors, flash separations, distillation/absorption columns etc.) is required.

### 529-0619-00L Chemical Product Design

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Faculty</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0619-00L</td>
<td>Chemical Product Design</td>
<td>W</td>
<td>7</td>
<td>W. J. Stark</td>
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</table>

**Prerequisites:** Basic chemistry and chemical engineering knowledge (Diffusion, Thermodynamics, Kinetics,...).

**Abstract**
The 'Chemical Product Design' course teaches students quantitative concepts to analyze, select and transform theoretical concepts from chemistry and engineering into valuable real-world products. Basic chemistry and chemical engineering knowledge is required (Diffusion, Thermodynamics, Kinetics, ...).

**Objective**
This course starts with analyzing existing chemical needs and unmet technical challenges. We then develop the skills to critically analyze a specific chemical idea for a product, to rapidly test feasibility or chance for success and to eventually realize its manufacturing. The chemical engineering basics are then used to assess performance of products or devices with non-traditional functions based on dynamic properties (e.g. responsive building materials; personal medical diagnostics on paper strips). The course teaches the interface between laboratory and market with a specific focus on evaluating the chemical value of a given process or compound, and the necessary steps to pursue the resulting project within an entrepreneurial environment. We therefore extend the questions of process design ("how do we make something?") to the question of "what should we make?"

**Content**
Part A: The 'Chemical Product Design' course starts with discussing questions along, ‘What is a chemical product, and why do people pay for it? How does a given compound in a specific setting provide a service?’ We then learn how to translate new, often ill-defined wishes or ideas into quantifiable specifications.

Part B: Thermodynamic and kinetic data allow sharp selection criteria for successful products. We learn how to deal with insufficient data and development of robust case models to evaluate their technical and financial constraints. How can parameters of a running process in one industry be scaled into another industry? Can dimensionless engineering numbers be applied beyond traditional chemical processes?

Part C: Manufacturing of commodity products, devices and molecular products: Chemical reactors, separation and detection or isolation units as part of a toolbox. Planning of manufacturing and decisions based on hard data. Providing quantitative answers on potential value generated.

Students are expected to actively develop chemical products along the course. Contributions will be made individually, or in small groups, where a larger topic is studied.

**Literature**

The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.


Preliminary process evaluation: simplified material and energy balances (linear balances), degrees of freedom, short-cut models, flowsheet solution algorithm.


Process economic evaluation: equipment sizing and costing, time value of money, cash flow calculations.

Batch Processes: scheduling, sizing and inventories.

Detailed Process Design: unit operation models, flash solution algorithms (different iterative methods, inside-out method), sequencing of nonideal distillation columns, networks of chemical reactors.

Lecture notes: no script

Prerequisites / Prerequisite: Thermal Unit Operations

Literature


Abstract

The purpose of the "Catalysis Engineering" course is to provide students with tools that enable the optimal design of catalytic materials and reactor engineering concepts favoring more sustainable manufacturing processes within the chemical industry.

Objectives

The course aims at illustrating, from conception to implementation, the design of sustainable catalytic processes by integration of the microlevel (catalyst), mesolevel (reactor), and macrolevel (process). The word "sustainable" implies intensified processes with an improved exploitation of raw materials, wider use of renewable feedstocks, reduction of energy consumption, and minimized environmental impact.

By the use of modern case studies of industrial relevance, aspects of catalyst preparation and characterization, kinetics, mass and heat transport, and deactivation are discussed. Emphasis is put on understanding the interaction among these basic elements in order to select the optimal catalytic process. Since no textbooks covering this area are available at this time and the intention of this course is unique, the lectures will be based on own texts and journal articles. During the course, there will be specific topics addressed by industrial contributors.

Content

The following general aspects:

- Catalyst preparation and characterization
- Kinetics
- Mass and heat transport
- Selectivity
- Deactivation

will be demonstrated for modern catalytic materials and processes of industrial relevance such as:

- Chlorine recycling
- N2O abatement
- Chemoselective hydrogenations
- Hierarchical zeolite catalysts
- SynGas conversion
- Biomass to chemicals and fuels

Lecture notes: The course material is based on an own script, journal articles, and slides.

Prerequisites / It is assumed that students selecting this course are familiar with general concepts of catalysis, reactor design, and transport phenomena.

Abstract

Microfluidics describes the behaviour, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

Objective

In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis.

A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale. The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.

Content

Specific topics in the course include, but not limited to:

1. Theoretical Concepts
   - Features of mass and thermal transport on the microscale
   - Key scaling laws
2. Microfluidic Device Manufacture
   - Conventional lithographic processing of rigid materials
   - Soft lithographic processing of plastics and polymers
   - Mass fabrication of polymeric devices
3. Unit operations and functional components
   - Analytical separations (electrophoresis and chromatography)
   - Chemical and biological synthesis
   - Sample pre-treatment (filtration, SPE, pre-concentration)
   - Molecular detection
4. Design Workshop
   - Design of microfluidic architectures for PCR, distillation & mixing
5. Contemporary Applications in Biological Analysis
   - Microarrays
   - Cellular analyses (single cells, enzymatic assays, cell sorting)
   - Proteomics
6. System integration
   - Applications in radiochemistry, diagnostics and high-throughput experimentation

Lecture notes: Lecture handouts, background literature, problem sheets and notes will be provided electronically.

Abstract

The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.

Objective

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   - Proteomics
6. System integration
   - Applications in radiochemistry, diagnostics and high-throughput experimentation

Lecture notes: Lecture handouts, background literature, problem sheets and notes will be provided electronically.
### Abstract
Projects on chemical assessment with the focus on the analysis and assessment of basic substance data for selected chemical classes; analysis and modelling of technical processes; characterisation of environmental and health risks. Risk assessment on the basis of quality and protection goals. Estimation of model and parameter uncertainty. Precrrent and precautionary measures.

### Objective
Project thesis (report) on chemicals assessment; time frame totals ca. 80 hours.

### Content
Projects on chemical assessment with the focus on the following aspects:

- Analysis and assessment of basic substance data for selected chemical classes: physical chemical properties, environmental behaviour (distribution, persistence), human and eco-toxicity (biochemical metabolism, effect mechanisms), safety.
- Analysis and modelling of technical processes determining chemical release into the environment, e.g., chemicals applications.
- Characterisation of environmental and health risks on the basis of exposure and effect models, QSARs from environmental chemistry, toxicology and methods of risk analysis.
- Risk assessment on the basis of quality and safety goals. Estimation of the model and data uncertainty.
- Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

Project teaching; time frame totals ca. 80 hours.

### Lecture notes
See recommended literature.

### Literature

### Prerequisites / notice
Voraussetzung: 529-0580-00L - Risikoanalyse chemischer Prozesse und Produkte oder: 701-0988-00L - Environmental and Human Health Risk Assessment of Chemicals

Beschränkt auf 6 Projektarbeiten pro Semester

### 529-0745-00L General and Environmental Toxicology

<table>
<thead>
<tr>
<th>Abstract</th>
<th>Objective</th>
<th>Content</th>
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<tbody>
<tr>
<td>Toxicokinetic and toxicodynamic aspects of xenobiotics with cellular structures and mechanisms. Toxic responses at the level of organs (immune-, neuro-, reproductive and genotoxicity) and organisms. Introduction into developmental toxicology and ecotoxicology.</td>
<td>Understanding of the impact of chemicals on biological systems; evaluation of the effects from different biomedical perspectives.</td>
<td>Explanation of important interactions between xenobiotic chemicals and cellular structures such as membranes, enzymes, and nucleic acids. Relevance of intake, distribution, excretion, and biochemical transformation processes. Relevance of mixtures. Explanation of important modes of toxic action such as immune toxicity, neurotoxicity, reproduction toxicity, genotoxicity based on examples of certain xenobiotics and their effects on important organs.</td>
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</tbody>
</table>

### Lecture notes
Course material will be handed out as the lectures progress

### Literature
Textbooks of pharmacology and toxicology (cf. list in course material)

### Prerequisites / notice
Educational basis: basic chemistry, biology and biochemistry

### 529-0659-00L Electrochemistry

<table>
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<tr>
<th>Abstract</th>
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<th>Content</th>
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### Lecture notes
Lecture notes will be distributed electronically during the course.

### Literature
Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks.

The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Introduction to native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an insusceptible material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.
**Laboratory Course, Research Project, and Case Study**

### Other Electives

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>227-0663-00L</td>
<td>Nano-Optics</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>L. Novotny</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Nano-Optics is the study of optical phenomena and techniques on the nanometer scale. It is an emerging field of study motivated by the rapid advance of nanoscience and technology. It embraces topics such as plasmonics, optical antennas, optical trapping and manipulation, and high-resolution imaging and spectroscopy.</td>
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<td></td>
<td>Understanding concepts of light localization and light-matter interactions on the nanoscale.</td>
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<td><strong>Content</strong></td>
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<td>Starting with an angular spectrum representation of optical fields the role of inhomogeneous evanescent fields is discussed. Among the topics are: theory of strongly focused light, point spread functions, resolution criteria, confocal microscopy, and near-field optical microscopy. Further topics are: optical interactions between nanoparticles, atomic decay rates in inhomogeneous environments, single molecule spectroscopy, light forces and optical trapping, photonic bandgap materials, and theoretical methods in nano-optics.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>- Electrodyamics (or equivalent)</td>
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<td>- Electrodynamics I+II</td>
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### Laboratory Course, Research Project, and Case Study

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<th>Number</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>529-0300-00L</td>
<td>Research Project</td>
<td>O</td>
<td>8</td>
<td>8A</td>
<td>Professors</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>First contact with experimental techniques of chemical engineering in a research group. Critical evaluation and presentation of the results in a scientific report.</td>
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<td><strong>Content</strong></td>
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<td>This laboratory project is organised during the spring vacation before the sixth semester. The participant can choose his topic from the list of projects suggested. Main emphasis during this research work is to get experience in using different engineering tools and evaluation and the interpretation of the results. Those are presented as a scientific report.</td>
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<th>Hours</th>
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<tbody>
<tr>
<td>529-0637-00L</td>
<td>Chemical Engineering Laboratory II</td>
<td>O</td>
<td>8</td>
<td>8P</td>
<td>M. Morbidelli, K. Hungerbühler, N. Kober, F. C. I. Meemken</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Introduction to the main specific areas in chemical and biochemical engineering. The students sharpen their laboratory skills and learn to plan and perform problem-oriented experiments and to analyse, interpret and present the results.</td>
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<td><strong>Objective</strong></td>
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<td>Introduction to the main specific areas in chemical and biochemical engineering. the students sharpen their laboratory skills and learn combined techniques to plan and perform problem-oriented experiments and to analyse, interpret and present the results.</td>
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<td><strong>Content</strong></td>
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<td>Teams of two students will conduct four or five experiments from the following areas: reactor stabilization, characterization of multiphase reactors, heterogeneous gas phase catalysis, polymer reaction engineering, process control and automation, safety and ecological analysis.</td>
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<th>Number</th>
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<tbody>
<tr>
<td>529-0459-00L</td>
<td>Case Studies in Process Design</td>
<td>O</td>
<td>7</td>
<td>3A</td>
<td>K. Hungerbühler, E. Capón García</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>The learning objective is to design, simulate and optimise a real (bio-)chemical process from a process systems perspective. Specifically, a commercial process simulation software will be used for the process simulation and optimisation. Students have to integrate knowledge and develop engineering thinking and skills acquired in the other courses of the curriculum.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>The learning objectives (LO) of this course are:</td>
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<td>LO 1: Create a model describing the production process</td>
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<td>- Students will apply a commercial process simulator systematically for process creation and analysis.</td>
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<td>- Students will create a simulation flowsheet for steady-state simulation.</td>
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<td>- Students will discriminate the models for the different process units.</td>
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<td>- Students will evaluate the sequencing in which process units associated with recycle loops are solved to obtain converged material and energy balances.</td>
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<td>LO 2: Evaluate the performance of the production process</td>
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<td>- Students will analyse and understand the degrees of freedom in modelling process units and flowsheets.</td>
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<td>- Students will make design specifications and follow the iterations implemented to satisfy them.</td>
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<td>- Students will judge the role of process simulators in equipment sizing and costing and profitability analysis.</td>
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<td>- Students will assess the economic performance of the process, including investment and operation costs.</td>
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<td>- Students will assess the environmental impact of the production process.</td>
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<td>LO 3: Optimise the design and operating conditions of the production process</td>
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<td>- Students will solve sensitivity analyses and optimisations are conducted considering technical and economic criteria.</td>
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<td>- Students will generate process integration alternatives to improve the initial production process.</td>
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<td>- Students will optimise the production process considering economic and environmental criteria.</td>
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</table>
Before the case study week, students do exercises in the course of Process Simulation and Flowsheeting in order to get familiar with Aspen Plus simulation software (compulsory). They also receive guidelines for environmental impact assessment and skills on oral presentations.

The problem statement and detailed instructions are provided at the beginning of the case study week.

During the case study week:
- Students work in teams of 3-5 people.
- Students have to pose and solve the different questions presented in the problem statement.
- Students have to coordinate the activities, the preparation of the written report and the oral presentation.
- Students will be assessed in specific questions they may find along the case study development.
- An industry expert, namely a chemical engineer from ETHZ, exchanges with the groups.

One week after the case study week, the groups deliver the written report.

One week later, the students receive the comments on the work done, and implement required corrections.

All the groups prepare a single presentation comparing the results and showing their achievements.

Finally, the students visit the real industrial process at the site. They also present their work to the industrial experts on the day of the industry visit.

**GESS Science in Perspective**

Recommended GESS Science in Perspective (Type B) for D-CHAB.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

**Master’s Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0600-00L</td>
<td>Master’s Thesis</td>
<td>O</td>
<td>20 credits</td>
<td>43D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:
- successful completion of the bachelor programme;
- fulfilling of any additional requirements necessary to gain admission to the master programme.

Duration of the Master’s Thesis 16 weeks.

Abstract

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is carried out in a research group of the Department of Chemistry and Applied Biosciences, usually in the Institute of Chemical and Bioengineering, as chosen by the student.

Objective

In the Master Thesis students prove their ability to independent, structured and scientific working.

**Course Units for Additional Admission Requirements**

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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</thead>
</table>

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract

The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Objective

The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Content

The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

Literature


Topic/Lecturer/Chapter/Pages:

Analyzing cells & molecules / Gebhard Schertler/8/ 439-463;
Membrane structure / Gebhard Schertler/10/ 565-596;
Compartmental Sorting/ Ulrike Kutay/12+14+6/641-694/755-758/782-783/315-320/325 -333/Table 6-2/Figure6-20, 6-21, 6-32, 6-34;
Intracellular Membrane Traffic/ Ulrike Kutay/13/695-752;
The Cytoskeleton/ Ulrike Kutay/16/889 - 948 (only the essentials);
Membrane Transport of Small Molecules and the Electrical Properties of Membranes /Sabine Werner/11/597 - 633;
Mechanisms of Cell Communication / Sabine Werner/15/813-876;
Cancer/ Sabine Werner/20/1091-1141;
Cell Junctions and Extracellular Matrix/Ueli Suter / 1035-1081;
Stem Cells and Tissue Renewal/Ueli Suter /1217-1262;
Development of Multicellular organisms/ Ernst Hafen/ 21/ 1145-1179 /1184-1198/1198-1213;
Cell Migration/Joao Matos/951-960;
Cell Death/Joao Matos/1021-1032;
Cell Cycle/chromosome segregation/Cell division/Melosis/Joao Matos/ 963-1018.
Abstract
The lecture course Biology II is a basic introductory course into biology for students who need to pass this course for admission to their MSc curriculum.

Objective
The objective of the lecture course Biology II is the understanding of form, function, and development of animals and of the basic underlying mechanisms.

Content
The following numbers of chapters refer to the text-book "Biology" (Campbell & Reece, 7th edition, 2005) on which the course is based. Chapters 1-4 are a basic prerequisite. The sections "Structure of the Cell" (Chapters 5-10, 12, 17) and "General Genetics" (Chapters 13-16, 18, 46) are covered by the lecture Biology I.

1. Genomes, DNA Technology, Genetic Basis of Development

Chapter 19: Eukaryotic Genomes: Organization, Regulation, and Evolution
Chapter 20: DNA Technology and Genomics
Chapter 21: The Genetic Basis of Development

2. Form, Function, and Development of Animals I

Chapter 40: Basic Principles of Animal Form and Function
Chapter 41: Animal Nutrition
Chapter 44: Osmoregulation and Excretion
Chapter 47: Animal Development

3. Form, Function, and Development of Animals II

Chapter 42: Circulation and Gas Exchange
Chapter 43: The Immune System
Chapter 45: Hormones and the Endocrine System
Chapter 48: Nervous Systems
Chapter 49: Sensory and Motor Mechanisms

Literature
The following text-book is the basis for the courses Biology I and II:


Prerequisites / notice
Prerequisite: Lecture course Biology I of winter semester
The course content is based on the following chapters of the textbook Biochemistry (Berg, Tymoczko, Stryer, 7th edition, 2012, Freeman & Co, New York)

Chapter 1: The molecular design of life
Chapter 2: Protein composition and structure
Chapter 3: Exploring proteins and proteomes
Chapter 4: DNA, RNA and the flow of information
Chapter 5: Exploring Genes and Genomes
Chapter 7: Hemoglobin
Chapter 8: Enzymes and the basic concepts of catalysis
Chapter 11: Carbohydrates
Chapter 12: Lipids and cell membranes
Chapter 15: Metabolism: Basic concepts and design

Chemical and Bioengineering Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Chemical Engineering Bachelor

1. Semester

Compulsory Subjects First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0011-02L</td>
<td>General Chemistry (Inorganic Chemistry) I</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>A. Togni</td>
</tr>
<tr>
<td>Objective</td>
<td>Understanding and describing ionic equilibria from both a qualitative and a quantitative perspective.</td>
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</tr>
<tr>
<td>Content</td>
<td>Chemical equilibrium and equilibrium constants, mono- and polyprotic acids and bases in aqueous solution, calculation of equilibrium concentrations, acidity functions, Lewis acids, acids in non-aqueous solvents, redox reactions and equilibria, Galvani cells, electrode potentials, Nernst equation, coordination chemistry, stepwise formation of metal complexes, solubility.</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Copies of the course slides as well as other documents will be provided as pdf files via the moodle platform.</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

| 529-0011-03L| General Chemistry (Organic Chemistry) I            | O    | 3    | 2V+1U | H. Wennemers                |
| Abstract    | An introduction to Organic Chemistry. Classical structure theory, stereochemistry, chemical bonds and bonding, symmetry, nomenclature, organic thermochemistry, conformational analysis, basics of chemical reactions. |
| Objective   | An introduction to the structures of organic compounds as well as the structural and energetic basis of organic chemistry. |
| Content     | Introduction to the history of organic chemistry, introduction to nomenclature, learning of classical structures and stereochemistry: isomerism, Fischer projections, CIPE rules, point groups, molecular symmetry and chirality, topicity, chemical bonding: Lewis bonding model and resonance theory in organic chemistry, description of linear and cyclic conjugated molecules, aromaticity, Huckel rules, organic thermochemistry, learning of organic chemistry reactions, intermolecular interactions. |
| Lecture notes | Underlagen werden als PDF über die ILIAS-Plattform zur Verfügung gestellt |

| 529-0011-01L| General Chemistry (Physical Chemistry) I           | O    | 3    | 2V+1U | F. Merkt                    |
| Abstract    | Atomic structure and structure of matter; Atomic orbitals and energy levels; Quantum mechanical atom model; Chemical bonding; Equations of state. |
| Objective   | Introduction to Physical Chemistry. |
| Content     | Atomic structure and structure of matter: atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic orbitals and energy levels: ionisation energies, atomic spectroscopy, term values and symbols. Quantum mechanical atom model: wave-particle duality, the uncertainty principle, Schrödinger’s equation, the hydrogen atom, construction of the periodic table of the elements. Chemical bonding: ionic bonding, covalent bonding, molecular orbitals. Equations of state: ideal gases. |
| Literature  | See homepage of the lecture. |
| Prerequisites / notice | Voraussetzungen: Maturastoff. Insbesondere Integral- und Differentialrechnung. |

| 551-0015-00L| Biology I                                           | O    | 2    | 2V   | R. Glockshuber, E. Hafen   |
| Abstract    | The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject. |
| Objective   | The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics. |
| Content     | The following Capitelnummern beziehen sich auf das der Vorlesung zugrundeliegende Lehrbuch "Biology" (Campbell & Rees, 10th edition, 2015) Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt |

1. Aufbau der Zelle
Kapitel 5: Struktur und Funktion biologischer Makromoleküle
Kapitel 6: Eine Tour durch die Zelle
Kapitel 7: Membranstruktur und Funktion
Kapitel 8: Einführung in den Stoffwechsel
Kapitel 9: Zelluläre Atmung und Speicherung chemischer Energie
Kapitel 10: Photosynthese
Kapitel 12: Der Zellzyklus
Kapitel 17: Vom Gen zum Protein

2. Allgemeine Genetik
Kapitel 13: Meiose und Reproduktionszyklen
Kapitel 14: Mendel'sche Genetik
Kapitel 15: Die chromosomale Basis der Vererbung
Kapitel 16: Die molekulare Grundlage der Vererbung
Kapitel 18: Genetik von Bakterien und Viren
Kapitel 46: Tierische Reproduktion

DAS folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:


Prerequisites / notice | Zur Vorlesung Biologie I gibt es während der Prüfungssektion eine einstündige, schriftliche Prüfung. Die Vorlesung Biologie II wird separat geprüft. |

| 401-0271-00L| Mathematical Foundations I: Analysis A              | O    | 5    | 3V+2U | L. Keller                  |
| Abstract    | Introduction to calculus in one dimension. Building simple models and analysing them mathematically. Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable. |
| Objective   | Introduction to calculus in one dimension. Building simple models and analysing them mathematically. |

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Content
Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.

Literature
G. B. Thomas, M. D. Weir, J. Hass: Analysis 1, Lehr- und Übungsbuch, Pearson-Verlag
D. W. Jordan, P. Smith: Mathematische Methoden für die Praxis, Spektrum Akademischer Verlag
R. Sperr/M. Avkeld: Analysis I (vdf)
L. Papula: Mathematik für Ingenieure und Naturwissenschaftler (3 Bände), Vieweg

529-0001-00L

Introduction to Computer Science
O 4 credits 2V+2U  P. H. Hübenerger

Abstract
Introduction to UNIX, data representation, introduction to C++ programming, errors, algorithms, computer architecture, sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, software engineering.

For more information: www.csms.ethz.ch/education/linfo

Objective
Discuss fundamentals of computer architecture, languages, algorithms and programming with an eye to their application in the area of chemistry, biology and material science.

Content
Minimal introduction to UNIX, Data representation and processing, algorithms and programming in C++, Errors, programming guidelines, efficiency, computer architecture, algorithms for sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, style, software engineering.

Lecture notes
Available (in English), distributed at first lecture

Literature
See: www.csms.ethz.ch/education/linfo

Prerequisites / notice
Since the exercises on the computer do convey test essentially different skills as those being conveyed during the lectures and tested at the written exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/linfo

Laboratory Courses

Number Title Type ECTS Hours Lecturers
529-0011-04L Practical Course General Chemistry ■ O 8 credits 12P H. V. Schönberg, E. C. Meister

Information about the practical course will be given on the first day.

Abstract
Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox reactions (synthesis, redox titrations, galvanic elements), metal complexes (syntheses, complexometric titration), analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)

Objective
Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kjeldahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox titrations, galvanic elements, metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration), analysis of measured values (measuring error, average value, error analysis), states of aggregation (vapour pressure), characteristics of electrolytes (conductivity measurements), thermodynamics (calorimetry)

Content
The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

Lecture notes
http://www.gruetzmacher.ethz.ch/education/labcourses

Prerequisites / notice
Compulsory: online enrolment latest one week prior start of the semester

3. Semester

Compulsory Subjects Examination Block I

Number Title Type ECTS Hours Lecturers
529-0121-00L Inorganic Chemistry I O 3 credits 2V+1U A. Mezzetti

Abstract
Complexes of the transition metals: structure, bonding, spectroscopic properties, and synthesis.

Objective
Introduction to the bonding theory in complexes of the transition metals. Interpretation of structure, bonding, and spectroscopic properties. General synthetic strategies.

Content
The chemical bond (overview). Symmetry and group theory. The chemical bond of coordination compounds (Valence Bond Theory, Crystal Field Theory, Molecular Orbital Theory (sigma- and pi-bonding), pi-Accepting ligands (CO, NO, olefins, dioxygen, dihydrogen, phosphines and phosphites). Electronic spectra of coordination compounds (Tanabe-Sugano diagrams). Coordination numbers and isomers in complexes. Dynamic phenomena (stereochemical nonrigidity). Complexes and kinetics.

Lecture notes
Can be bought at the HCI-shop

Literature

529-0221-00L Organic Chemistry I O 3 credits 2V+1U F. Diederich, C. Schaack

Abstract
Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Objective
Acquisition of a basic repertoire of synthetic methods including important reactions of aldehydes, ketones, carboxylic acids and carboxylic acid derivatives, as well as eliminations and fragmentations. Particular emphasis is placed on the understanding of reaction mechanisms and the correlation between structure and reactivity. A deeper understanding of the concepts presented during the lecture is reached by solving the problems handed out each time and discussed one week later in the exercise class.

Content
Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Lecture notes
A pdf file of the printed lecture notes is provided online. Supplementary material may be provided online.

Literature
No set textbooks. Optional literature will be proposed at the beginning of the class and in the lecture notes.

529-0422-00L Physical Chemistry II: Introduction to Chemical O 4 credits 3V+1U H. J. Wörner

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 380 of 1571
Reaction Kinetics

Abstract

Objective
Introduction to Chemical Reaction Kinetics

Content
Fundamental concepts: rate laws, elementary reactions and composite reactions, molecularity, reaction order. Experimental methods in reaction kinetics up to new developments in femtosecond kinetics. Simple chemical reaction rate theories: temperature dependence of the rate constant and Arrhenius equation, collision theory, reaction cross-section, transition state theory. Reaction mechanisms and complex kinetic systems, approximation techniques, chain reactions, explosions and detonations. Homogeneous catalysis and enzyme kinetics.

Lecture notes

Literature

Prerequisites / notice
Voraussetzungen:
- Mathematik I und II
- Allgemeine Chemie I und II
- Physikalische Chemie I

402-0043-00L Physics I O 4 credits 3V+1U T. Esslinger

Abstract
Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

Objective
The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.

Content
Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids)
Periodic Motion and Waves (periodic motion, mechanical waves, acoustics)

Lecture notes
The lecture follows the book "Physics" by Paul A. Tipler.

Literature
- Paul A. Tipler and  Gene P. Mosca, Physics (for Scientists and Engineers), W. H. Freeman and Company

Prerequisites / notice
Prerequisites: Mathematics I & II

529-0051-00L Analytical Chemistry I O 3 credits 3G D. Günther, M.O. Ebert, R. Zenobi

Abstract
Introduction into the most important spectroscopical methods and their applications to gain structural information.

Objective
Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications

Content
Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:
Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.
UV/VIS spectroscopy: Basics, interpretation of electron spectra. Circular dichroism (CD) und optical rotation dispersion (ORD).

Lecture notes
Script will be for the production price

Literature
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

Prerequisites / notice
Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounts" (4th semester) is recommended.

401-0373-00L Mathematics III: Partial Differential Equations O 4 credits 2V+1U F. Da Lio

Abstract

Objective
The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.
Content

## Examples of partial differential equations
- Classification of PDEs
- Superposition principle

## One-dimensional wave equation
- D'Alembert's formula
- Duhamel's principle

## Fourier series
- Representation of piecewise continuous functions via Fourier series
- Examples and applications

## Separation of variables
- Resolution of wave and heat equation
- Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

## Laplace equation
- Resolution of the Laplace equation on rectangle, disk and annulus
- Poisson formula
- Mean value theorem and maximum principle

## Fourier transform
- Derivation and Definition
- Inverse Fourier transformation and inversion formula
- Interpretation and properties of the Fourier transform
- Resolution of the heat equation

## Laplace transform
- Definition, motivation and properties
- Inverse Laplace transform of rational functions
- Application to ordinary differential equations

### Lecture notes
There are available some Lecture Notes in English and also in German of the Professor. These can be found following the links provided under the tab ‘Lernmaterialien’.

### Literature
2) Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations, Cambridge University Press
3) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (only Chapters 1,2,6,11)

### Prerequisites / notice
Prerequisites:
- Practical Course General Chemistry (1. Semester, 529-0011-04)
- Practical Course Inorg. and Org. Chemistry I (2. Sem., 529-0230)
- Attendance of Course Inorg. Chemistry 1 (3. Sem., 529-0121)

5. Semester

### Compulsory Subjects

#### Examination Block Thermodynamics and Transport Phenomena

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
---|---|---|---|---|---
529-0557-00L | Chemical Engineering Thermodynamics | O | 4 credits | 3G | A. Butté

**Abstract**
This course teaches the fundamentals of thermodynamics applied to the description of real mixtures in the presence of physicochemical equilibria, including methods to quantitatively estimate them. While giving insights into the meaning and properties of main thermodynamic quantities, the course keeps primary focus on application to real chemical engineering problems.

**Objective**
The objective of the course is twofold. First, to teach the methods to calculate the volumetric and thermodynamic properties of mixtures in the presence of physicochemical equilibria. In particular, students are supposed to acquire the knowledge on which thermodynamic properties have to be estimated to carry out such calculation, on which data which need to be gathered and estimated, on the methods, the relative assumption and approximations. Second, the course is intended to give the students a sufficient theoretical insight on the thermodynamic properties, which will be used for future applications and studies.
The first part of the course is focusing on pure fluids (ideal and real). First, some fundamentals of thermodynamics are reviewed, including thermodynamic quantities and balances (of mass, energy and entropy). Then, equations of state and their use to estimate the volumetric properties of pure fluids are introduced. Finally, it is discussed how to use previous results for the estimation of the main thermodynamic properties (internal energy, enthalpy, entropy, free Gibbs energy, fugacity, etc.).

The second part of the course is focusing on mixtures, starting from binary mixture to mixtures of N components. Again, real mixtures are discussed, with emphasis on when such mixtures can be approximated as ideal ones and on the corrections which are needed to switch from ideal to real mixtures. As for pure fluids, first the use of the equations of state is discussed to estimate volumetric properties, then the estimation of the thermodynamic properties of mixtures is introduced. In this part, a particular focus is given to phase equilibria in the absence of chemical reactions. The most common equilibria (liquid-vapor, solid-liquid, liquid-liquid, etc) are discussed.

In the last part of the course, the chemical equilibria are discussed, with particular focus on the calculation of mass and energy balances for multicomponent systems (mixtures), also in the presence of physical equilibria. During the lectures, theoretical aspects will be discussed and will be linked to application by the discussion of a comprehensive study case, including the methods for its solution. Detailed exercises will be given (and discussed later) to the students, to let them familiarize with the main methods discussed during the lecture.

Books on this subject can be mostly found under the title: 'Chemical Engineering Thermodynamics', 'Thermodynamics for Chemical Engineers', or 'Chemical Process Principles'. A selection:


Acquisition of material properties and data:

11. "TRC Thermodynamic Tables", Thermodynamic Research Center, College Station USA

Knowled in chemical thermodynamics required

151-0917-00L Mass Transfer O 4 credits 2V+2U R. Büchel, S. E. Pratsinis

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Content
Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogeneous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

Literature

529-0636-00L Heat Transport and Fluid Dynamics ■ O 4 credits 4G A. A. Kubik

This course teaches the basis and the methods for the description and for the quantitative treatment of heat transfer and fluid flow with emphasis on physico-chemical processes.

Content
Mechanisms of heat and momentum transfer; analogy between mass, heat and momentum transfer; dimensional analysis; kinematics and continuum mechanics; steady and non-steady laminar and turbulent flows; inviscid flows; Bernoulli equation; Navier-Stokes equations; boundary layer theory; steady and non-steady heat conduction; convective heat transfer; heat transfer correlations; radiative heat transfer

Lecture notes
Lecture notes will be handed out

529-0632-00L Homogeneous Reaction Engineering O 4 credits 3G M. Morbidelli, T. Casalini

752-4001-00L  
Microbiology  
O  2 credits  2V  M. Schuppler, S. Schlegel, J. Vorhoft-Zambelli

Abstract  
Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.

Objective  
Teaching of basic knowledge in microbiology.

Content  

Literature  
Wird von den jeweiligen Dozenten ausgegeben.

Lecture notes  
Scripts are available on line on the web page of the Morbidelli group.

Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Objective  
Provide to the students a complete methodology for the analysis and design of homogeneous reactors

Content  

Literature  
J. Baldyga and J.R. Bourne, Turbulent Mixing and Chemical Reactions, John Wiley, 1999  
A. Varma and M. Morbidelli, Mathematical Methods in Chemical Engineering, Oxford University Press, 1997

401-0675-00L  
Statistical and Numerical Methods for Chemical Engineers  
O  3 credits  2V+2U  R. Käppeli, P. Müller, M. Sokolov

Abstract  
This course covers commonly numerical algorithms and statistical methods used by chemical engineers to solve typical problems arising in industrial and research practice.

Objective  
This course covers commonly numerical algorithms and statistical methods used by chemical engineers to solve typical problems arising in industrial and research practice. The focus is on application of these algorithms to real world problems, while the underlying mathematical principles are also explained. The MATLAB environment is adopted to integrate computation, visualization and programming.

Content  
Topics covered:

Part I: Numerical Methods:
- Interpolation & Numerical Calculus
- Non-linear Equations
- Ordinary Differential Equations
- Partial Differential Equations
- Linear and Non-linear Least Squares

Part II: Statistical Methods:
- Data analysis and regression methods
- Statistical experimental design
- Multivariate analysis of spectra

Lecture notes  
For the numerics part, see http://www.sam.math.ethz.ch/~karoger/nunci/2016/

For the statistics part, see http://stat.ethz.ch/~muellepa/

Recommended reading:
2) A. Constantinides, N. Mostoufi, Numerical Methods for Chemical Engineers with Matlab Applications, Prentice Hall, 1999
4) W. A. Stahel, Statistische Datenanalyse, Vieweg, 4th edition 2002

351-0778-00L  
Discovering Management  

Abstract  
Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Objective  
Discovering Management combines in an innovative format a set of lectures and an advanced business game. The learning model for Discovering Management involves 'learning by doing'. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant as someone exploring innovation within an organisation as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.

Content  
Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the independency of various topics in the development and management of a firm. The lectures introduce students not only to topics relevant for managing large corporations, but also touch upon the different aspects of starting up your own venture. The lectures will be presented by the respective area specialists at D-MTEC. The course broadens the view and understanding of technology by linking it with its commercial applications and with society. The lectures are designed to introduce students to topics related to strategy, corporate innovation, leadership, corporate and entrepreneurial finance, value chain analysis, corporate social responsibility, and business model innovation. Practical examples from industry experts will stimulate the students to critically assess these issues. Creative skills will be trained by the business game exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of Chief Innovation Officer of a large multinational company. As they learn more about the specific case and identify the challenge they are faced with, the students will have to develop an innovative business case for this multinational corporation. Doing so, this exercise will provide an insight into the context of managerial problem-solving and corporate innovation, and enhance the students' appreciation for the complex tasks companies and managers deal with. The business game presents a realistic model of a company and provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyse the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

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Prerequisites / notice

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich.

No prior knowledge of business or economics is required to successfully complete this course.

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### Examination Block Catalysis and Heterogeneous Process Engineering

**Subjects will be given in spring semester**

### Examination Block Process Engineering

**Subjects will be given in spring semester**

### Laboratory Courses and Case Studies

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**
The focus of part I of the case study course lies on the literature-based comparison of chemical process alternatives. Based on this compilation and selected quantitative as well as qualitative measures a process assessment and comparison is conducted and the most promising process alternative is chosen for further evaluation, and a basic flowsheet and mass and energy balances are generated.

**Objective**
- to obtain knowledge about different databases and sources of information
- application of the knowledge obtained in lectures
- problem-oriented problem solving (application of different methods to the same subject)
- team work
- report writing and presentation techniques

**Content**
The focus of part I of the case study course lies on the literature-based comparison of chemical process alternatives. For this purpose relevant substance data (i.e. physico-chemical, toxicological, safety, and environmental data) as well as information about synthesis routes and technical implementations (i.e. on reaction kinetics; possible separation operations; economic, safety, and environmental aspects) are collected from the literature. Based on this compilation and selected quantitative as well as qualitative measures a process assessment and comparison is conducted and the most promising process alternative is chosen for further evaluation. For this alternative a basic flowsheet and mass and energy balances are generated.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0639-01L</td>
<td>Chemical Engineering Laboratory I</td>
<td>O</td>
<td>6 credits</td>
<td>8P</td>
<td>M. Morbidelli, N. Kober</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to various tools of chemical engineering techniques with reference to the lectures. In groups of two, students will conduct experiments in the following areas: thermodynamics and phase equilibria including electrochemistry, transport phenomena, kinetics and selectivity of complex reactions, characterisation of ideal and real reactors.

**Objective**
Introduction to various tools of chemical engineering techniques with reference to the running lectures.

**Content**
In groups of two, students will conduct selected experiments in the following areas: thermodynamics and phase equilibria including electrochemistry, transport phenomena, kinetics and selectivity of complex reactions, characterisation of ideal and real reactors.

---

**GESS Science in Perspective**

- see GESS Science in Perspective: Type A: Enhancement of Reflection Capability
- see GESS Science in Perspective: Language Courses ETH/UZH
- Recommended GESS Science in Perspective (Type B) for D-CHAB

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**Chemical Engineering Bachelor - Key for Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Code</th>
<th>Eligibility</th>
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<tbody>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
<td>W</td>
<td>Eligible for credits</td>
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**Key for Hours**

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<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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<td></td>
</tr>
</tbody>
</table>

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**ECTS**

- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Comparative and International Studies Master

Core Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0001-00L</td>
<td>Methods I: Research Design, Qualitative Methods, and Data Collection</td>
<td>O</td>
<td>8 credits</td>
<td>2U+2S</td>
<td>F. Schimmelfennig, J. Thiel, T. Winzen</td>
</tr>
<tr>
<td>857-0002-00L</td>
<td>Democracy</td>
<td>O</td>
<td>8 credits</td>
<td>2S</td>
<td>F. Schimmelfennig, D. Kübler</td>
</tr>
<tr>
<td>857-0003-00L</td>
<td>Political Violence</td>
<td>O</td>
<td>8 credits</td>
<td>2S</td>
<td>A. Wenger, C. Bara</td>
</tr>
<tr>
<td>857-0004-00L</td>
<td>Methods II: Quantitative Methods</td>
<td>O</td>
<td>4 credits</td>
<td>2S</td>
<td>M. Steenbergen</td>
</tr>
<tr>
<td>857-0005-00L</td>
<td>Technology Governance and International Security</td>
<td>W</td>
<td>8 credits</td>
<td>2S</td>
<td>M. Dunn Cavelti</td>
</tr>
<tr>
<td>857-0006-00L</td>
<td>Comparative and International Political Economy</td>
<td>W</td>
<td>8 credits</td>
<td>2S</td>
<td>V. Koubi, L. Beiser-McGrath</td>
</tr>
<tr>
<td>857-0007-00L</td>
<td>Students will acquire an advanced understanding of some of the key issues and arguments in comparative and international political economy. This MACIS core seminar covers basic issues of research design, small-n research, and data collection. It familiarizes students with general research design problems such as defining research questions, analyzing causality, and designing single and comparative case studies. It then introduces them to basic issues in small-n research. Students acquire an understanding of the specific challenges and design problems in qualitative analysis. Finally, students are introduced to exemplary methods of data collection. By the end of the course, students will be able to use the principal methods of data collection used by political scientists. They will understand the advantages and disadvantages of the methods, and should be able to reflect on and discuss the methods in light of research questions of their interest.</td>
<td></td>
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</tr>
<tr>
<td>857-0008-00L</td>
<td>This course offers an introduction to political violence in domestic and international politics. The course covers explanations of interstate wars, theories of civil and ethnic wars and regional conflict. Other topics include new threats, including transnational terrorist networks and other non-state actors, and the relationship between conflict and nation-building and democratization processes.</td>
<td></td>
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</tr>
<tr>
<td>857-0009-00L</td>
<td>This seminar is restricted to students enrolled in the MACIS program. This research seminar complements the MACIS core seminar in Political Economy. It covers topics such as international trade, environmental policy, international finance and foreign direct investment, and welfare state policy. Students will, based on reading assignments and discussions in class, develop a research question, present a research design, and write a paper.</td>
<td></td>
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</tbody>
</table>

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 386 of 1571
This advanced research seminar deals with current issues and research in comparative politics and EU integration and politics. It introduces students to state-of-the-art theorizing, data, methods, and empirical findings and provides them with opportunities to work with data on their own. After taking this seminar, students should have a good overview of current research and be prepared to write their Master's thesis in this area. Topics include: European integration, EU decision-making, parliaments in the EU and its member states, party groups and parliamentarians. Students may also propose research topics of their interest.

**Electives**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0003-00L</td>
<td>Introduction to Security Studies ■</td>
<td>W</td>
<td>4 credits</td>
<td>2S</td>
<td>F. Schimmelfennig</td>
</tr>
<tr>
<td>857-0054-00L</td>
<td>International Environmental Politics</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>T. Bernauer</td>
</tr>
<tr>
<td>857-0027-00L</td>
<td>International Organizations (Field Trip)</td>
<td>W</td>
<td>2 credits</td>
<td>1S</td>
<td>F. Schimmelfennig</td>
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<tr>
<td>860-0001-00L</td>
<td>Public Institutions and Policy-Making Processes</td>
<td>W</td>
<td>3 credits</td>
<td>3G</td>
<td>T. Bernauer, S. Bechtold, F. Schimmelfennig</td>
</tr>
</tbody>
</table>

**Objective**

This seminar is designed for advanced students with an interest in comparative European politics and EU integration and politics. It introduces students to state-of-the-art theorizing, data, methods, and empirical findings and provides them with opportunities to work with data on their own. After taking this seminar, students should have a good overview of current research and be prepared to write their Master's thesis in this area. Topics include: European integration, EU decision-making, parliaments in the EU and its member states, party groups and parliamentarians. Students may also propose research topics of their interest.

**Content**

This course is designed to familiarize students with the work and challenges of international organizations based in Geneva. It introduces students to state-of-the-art theorizing, data, methods, and empirical findings and provides them with opportunities to work with data on their own. After taking this seminar, students should have a good overview of current research and be prepared to write their Master's thesis in this area. Topics include: European integration, EU decision-making, parliaments in the EU and its member states, party groups and parliamentarians. Students may also propose research topics of their interest.

**Literature**

All texts will be available online.

**Prerequisites / notice**

Class will only take place with a minimum of 5 students and is limited to approx. 15 participants. MACIS students are given priority.
Schedule (for up-to-date information, see the syllabus that will be distributed to participants electronically):

W1: Bechtold, Bernauer: Introduction
How are laws created and interpreted? How are they enforced?
W2: Bechtold: Why do we need laws and why do people and firms usually obey the law? What are possible goals of legal systems? What is the relationship between laws, social norms, and moral values?
W3: Bechtold: What role does scientific evidence play in the creation and enforcement of the law? How does the law deal with non-quantifiable factors or incommensurable values?
W4: no class
W5: Bernauer: How are parliaments (legislatures) elected, how do they work, and how do their characteristics and processes affect policy-making?
W6: Bernauer: Why do forms of government differ and how does this affect policy-making? Why and in what respect are public administrations efficient/effective, and why sometimes not?
W7: Bernauer: How do interest groups and social movements affect policy-making.
W8: Study week
W9: Schimmelfennig: Governance beyond the state: why and how states create international institutions.
W10: Schimmelfennig: International organizations and regimes: case studies of global governance.
W11: Schimmelfennig: Institutions and policy-making in the European Union.
W12: Schimmelfennig: International organizations and policy diffusion.
W13: End-of-semester exam

An add-on module to this course (3 ECTS) involves an essay. This part of the course is accessible only to ISTP MSc students and requires enrollment in the main course (3 ECTS). ISTP MSc students must enrol in both parts. Other students can only enrol in the main course.

3rd week of January: deadline for review essay

Prerequisites / notice

W10: Schimmelfennig: Institutions and policy-making in the European Union.
W11: Schimmelfennig: Institutions and policy-making in the European Union.
W13: End-of-semester exam

An add-on module to this course (3 ECTS) involves an essay. This part of the course is accessible only to ISTP MSc students and requires enrollment in the main course (3 ECTS). ISTP MSc students must enrol in both parts. Other students can only enrol in the main course.

3rd week of January: deadline for review essay

Lecture notes
Reading materials will be distributed electronically to the students when the semester starts.

Lecture notes:


This is a Master level course. The course is capped at 25 students, with ISTP Master students having priority.

Objective
Public policies result from decision-making processes that take place within formal institutions of the state (parliament, government, public administration, courts). That is, policies are shaped by the characteristics of decision-making processes and the characteristics of public institutions and related actors (e.g., interest groups). In this course, students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels, and what challenges arise in this regard. The course is organized in three modules. The first module (Stefan Bechtold) examines basic concepts and the role of law, law-making, and law enforcement in modern societies. The second module (Thomas Bernauer) deals with the functioning of legislatures, governments, and interest groups. The third module (Frank Schimmelfennig) focuses on the European Union and international organizations.

Content
851-0609-06L Governing the Energy Transition W 2 credits 2V T. Schmidt

Number of participants limited to 30.

Primarily suited for Master and PhD level

This course addresses the role of policy and its underlying politics in the transformation of the energy sector. It covers historical, socio-economic, and political perspectives and applies various theoretical concepts to specific aspects of governing the energy transition.

- To gain an overview of the history of the transition of large technical systems
- To recognize current challenges in the energy system to understand the theoretical frameworks and concepts for studying transitions
- To demonstrate knowledge on the role of policy and politics in energy transitions
Content
Climate change, access to energy and other societal challenges are directly linked to the way we use and create energy. Both the recent United Nations Paris climate change agreement and the UN Sustainable Development Goals make a fast and extensive transition of the energy system necessary.

This course introduces the social and environmental challenges involved in the energy sector and discusses the implications of these challenges for the rate and direction of technical change in the energy sector. It compares the current situation with historical socio-technical transitions and derives the consequences for policy-making. It then introduces theoretical frameworks and concepts for studying innovation and transitions. It then focuses on the role of policy and policy change in governing the energy transition, considering the role of political actors, institutions and policy feedback.

The course has a highly interactive (seminar-like) character. Students are expected to actively engage in the weekly discussions and to give a presentation (15-20 minutes) on one of the weekly topics during that particular session. The presentation (30%) and participation in the discussions (20%) will form one part of the final grade, the remaining 50% of the final grade will be formed by a final exam.

Prerequisites / notice
This course is particularly suited for students of the following programmes: MA Comparative International Studies; MSc Energy Science & Technology; MSc Environmental Sciences; MSc Management, Technology & Economics; MSc Science, Technology & Policy; ETH & UZH PhD programmes.

Lecture notes
Slides and reading material will be made available via moodle.ethz.ch (only for registered students).

Literature

**857-0075-00L** Contemporary European Politics
- W 4 credits
- 2S
- C. Kaya, F. Karstens, J. Moreno Rocabert, R. Schrama, T. Winzen

**865-0067-00L** Foundations of Sustainable Development Practice
- W 1 credit
- 1G
- D. Molnar, R. Batliner

**865-0010-02L** Food Security and Agriculture
- W 2 credits
- 3G
- L. B. Nilsen

**860-0006-00L** Applied Statistics and Policy Evaluation
- W 3 credits
- 3G
- I. Günther, K. Harttgen

Number of participants limited to 20.
Objective
- have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software STATA for data analysis

Content
The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.

Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0019-00L</td>
<td>Master's Thesis Colloquium •</td>
<td>O</td>
<td>4 credits</td>
<td>3K</td>
<td>D. Bischof</td>
</tr>
</tbody>
</table>

Permission to begin master thesis is required to take part in Colloquium.

Abstract
In this colloquium, students enrolled in the MACIS program first present and discuss research design and methods issues concerning their prospective MA theses. Towards the end of the semester they present preliminary findings from their MA thesis work.

Objective
It is the goal of the colloquium to help students with the initial steps of writing their master theses. During the colloquium, they will develop a relevant research question and hypotheses and select appropriate methods and data.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>857-0021-00L</td>
<td>Master's Thesis •</td>
<td>O</td>
<td>26 credits</td>
<td>56D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:
- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract
The Master Thesis is an independent piece of research on an issue in comparative and international politics. It combines theory, methods, and empirical work.

Objective
The Thesis should demonstrate the students' ability to conduct independent research on the basis of the theoretical and methodological knowledge acquired during the MA program.

Comparative and International Studies Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ECTS: European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>262-5120-00L</td>
<td>Principles of Evolution: Theory (University of Zurich)</td>
<td>W</td>
<td>6 credits</td>
<td>3V</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Abstract
"Nothing in Biology Makes Sense Except in the Light of Evolution". Evolutionary theory and methods are essential in all branches of modern biology.

Objective
Subject specific skills:
- By the end of the course, students will be able to:
  - describe basic evolutionary theory and its applications
  - discuss ongoing debates in evolutionary biology
  - critically assess the presentation of evolutionary research in the popular media

Key skills:
- By the end of the course, students will be able to:
  - approach biological questions from an evolutionary perspective

Content
This course will provide a broad overview of current evolutionary thought, including the mechanisms of evolutionary change, adaptation and the history of life and will involve practical field and lab work as well as lecture material.

401-6282-00L Statistical Analysis of High-Throughput Genomic and Transcriptomic Data (University of Zurich)

Abstract
A range of topics will be covered, including basic molecular biology, genomics technologies and in particular, a wide range of statistical and computational methods that have been used in the analysis of DNA microarray and high throughput sequencing experiments.

Objective
- Understand the fundamental "scientific process" in the field of Statistical Bioinformatics
- Be equipped with the skills/tools to preprocess genomic data (Unix, Bioconductor, mapping, etc.) and ensure reproducible research (Sweave)
- Have a general knowledge of the types of data and biological applications encountered with microarray and sequencing data
- Have the general knowledge of the range of statistical methods that get used with microarray and sequencing data
- Gain the ability to apply statistical methods/knowledge/software to a collaborative biological project
- Gain the ability to critical assess the statistical bioinformatics literature
- Write a coherent summary of a bioinformatics problem and its solution in statistical terms

Content
Lectures will include: microarray preprocessing; normalization; exploratory data analysis techniques such as clustering, PCA and multidimensional scaling; Controlling error rates of statistical tests (FPR versus FDR versus FWER); limma (linear models for microarray analysis); mapping algorithms (for RNA/ChIP-seq); RNA-seq quantification; statistical analyses for differential count data; isoform switching; epigenomics data including DNA methylation; gene set analyses; classification

Lecture notes
Lecture notes, published manuscripts

Prerequisites / notice
Prerequisites: Basic knowledge of the programming language R, sufficient knowledge in statistics

Former course title: Statistical Methods for the Analysis of Microarray and Short-Read Sequencing Data

551-0307-00L Molecular and Structural Biology I: Protein Structure and Function

Abstract
Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

Objective
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

Lecture notes
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

Literature
Basics:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.

636-0007-00L Computational Systems Biology

Abstract
Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.
Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label “Systems Biology”, focuses on how networks, which are more than the mere sum of their parts’ properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks. We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

**Objective**
The goal of this course is to understand and to appreciate mathematical models and computational methods that provide insight into the evolutionary process.

**Content**
Evolution is the one theory that encompasses all of biology. It provides a single, unifying concept to understand the living systems that we observe today. We will introduce several types of mathematical models of evolution to describe gene frequency changes over time in the context of different biological systems, focusing on asexual populations. Viruses and cancer cells provide the most prominent examples of such systems and they are at the same time of great biomedical interest. The course will cover some classical mathematical population genetics and population dynamics, and also introduce several new approaches. This is reflected in a diverse set of mathematical concepts which make their appearance throughout the course, all of which are introduced from scratch. Topics covered include the quasispecies equation, evolution of HIV, evolutionary game theory, birth-death processes, evolutionary stability, evolutionary graph theory, somatic evolution of cancer, stochastic tunneling, cell differentiation, hematopoietic tumor stem cells, genetic progression of cancer and the speed of adaptation, diffusion theory, fitness landscapes, neutral networks, branching processes, evolutionary escape, and epistasis.

**Lecture notes**
No.

**Literature**

**Prerequisites / notice**
Prerequisites: Basic mathematics (linear algebra, calculus, probability)

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**Content**
Computational Biology is concerned with the mathematical principles according to which life has evolved. This course offers an introduction to mathematical modeling of evolution, including deterministic and stochastic models.

**Objective**
The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.

**Content**
The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

**Lecture notes**
Slides of the lecture will be available online.
https://www.bsse.ethz.ch/cevo/education/cb-materials.html

**Literature**
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
- * pathogen evolution
- * macroevolution of species

**Prerequisites / notice**
Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

---

**Content**
This course focuses on modeling spatio-temporal problems in biology, in particular on the cell and tissue level. A wide range of mathematical techniques will be presented as part of the course, including concepts from non-linear dynamics (ODE and PDE models), stochastic techniques (SDE, Master equations, Monte Carlo simulations), and thermodynamic descriptions. The course aims at equipping students with the tools and concepts to conduct successful research in this area; both classical as well as recent research work will be discussed.

**Objective**
The aim of the course is to introduce students to state-of-the-art mathematical modelling of spatio-temporal problems in biology. Students will learn how to choose from a wide range of modelling techniques and how to apply these to further our understanding of biological mechanisms. The course aims at equipping students with the tools and concepts to conduct successful research in this area; both classical as well as recent research work will be discussed.
1. Introduction to Modelling in Biology

Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on

2. Morphogen Gradients

3. Turing Pattern

4. Travelling Waves & Wave Pinning

5. Application Example 1: Dorsal-ventral axis formation

6. Chemotaxis, Cell Adhesion & Migration

7. Introduction to Numerical Methods

8. Simulations on Growing Domains

9. Image-Based Modelling

10. Branching Processes

11. Cell-based Simulation Frameworks

12. Application Example 2: Limb Development

13. Summary

Lecture notes

All lecture material will be made available online

https://www.bsse.ethz.ch/cobi/education/636-0706-00L_Spatial_Modelling_in_Biology.html

Literature

Murray, Mathematical Biology, Springer

Fogacs and Newman, Biological Physics of the Developing Embryo, CUP

Keener and Sneyd, Mathematical Physiology, Springer

Fall et al, Computational Cell Biology, Springer

Szallasi et al, System Modeling in Cellular Biology, MIT Press

Wolkenhauer, Systems Biology

Kreyzig, Engineering Mathematics, Wiley

Prerequisites / notice

The course builds on introductory courses in Computational Biology. The course assumes no background in biology but a good foundation regarding mathematical and computational techniques.

Advanced Courses

Advanced Courses and Methods of Computer Science

Title: Discrete Mathematics

Content: Mathematical reasoning and proofs, abstraction. Sets, relations (e.g. equivalence and order relations), functions, (un-)countability, number theory, algebra (groups, rings, fields, polynomials, subalgebras, morphisms), logic (propositional and predicate logic, proof calculi).

Objective

The primary goals of this course are (1) to introduce the most important concepts of discrete mathematics, (2) to understand and appreciate the role of abstraction and mathematical proofs, and (3) to discuss a number of applications, e.g. in cryptography, coding theory, and algorithm theory.

Course notes

To see course description.

Lecture notes

Available (in English)

Title: Neuromorphic Engineering I

Registration in this class requires the permission of the instructors. Class size will be limited to available lab spots. Preference is given to students that require this class as part of their major.

Abstract

This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

Objective

Understanding of the characteristics of neuromorphic circuit elements.

Content

Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

Literature

S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

Prerequisites / notice

Particular: The course is highly recommended for those who intend to take the spring semester course 'Neuromorphic Engineering II', that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 393 of 1571
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

529-0004-00L  Computer Simulation in Chemistry, Biology and Physics

Abstract
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Objective
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content
Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Lecture notes
Available (copies of powerpoint slides distributed before each lecture)

Literature
See: www csms ethz ch/education/CSCBP

Prerequisites / notice
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/CSCBP

529-0733-00L  Enzymes

Abstract
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Objective
Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

Content
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Lecture notes
A script will not be handed out.

Literature

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

535-0810-00L  Gene Technology

Abstract
The course will provide a solid overview of the science and issues in gene technology and its pharmaceutical applications.

Objective
The aim of the lecture course is to provide a solid overview of gene technology, with a special focus on drug development. Topics: Antibody phage technology, DNA-encoded chemistry, protein modification technology, genome sequencing, transcriptomics, proteomics, functional genomics, principle of drug discovery. The course is suited for advanced undergraduate and early graduate students in pharmaceutical sciences or related fields.

Content
1. Antibody phage technology
The antibody molecule
V genes, CDRs, basics of antibody engineering
Principles of phage display
Phagemid and phage vectors
Antibody libraries
Phage display selection methodologies
Other phage libraries (peptides, globular proteins, enzymes)
Alternative screening/selection methodologies
DNA-encoded chemical libraries

2. Proteins: chemical modification and detection of biomolecular interactions
Homo- and hetero-dimerization of proteins
Chemical modifications of proteins
Antibody-drug conjugates
Radioactive labeling of proteins
Kinetic association and dissociation constants
Affinity constant: definition and its experimental measurement

3. Genomics: Applications to Human Biology
Protein cloning and expression
DNA sequencing
Some foundations of genetic analysis
Knock-out technologies
Transcriptomics
Proteomics
Recombinant vaccines

4: Pharmaceuticals: Focus on Discovery
Ligand Discovery
Half-life extension
Cancer therapy
Gene therapy

Lecture notes
Skript "Gene Technology" by Prof. Dario Neri and slides of the lecture

551-0307-00L  Molecular and Structural Biology I: Protein Structure

Abstract
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

Objective
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content
Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Lecture notes
Available (copies of powerpoint slides distributed before each lecture)

Literature
See: www csms ethz ch/education/CSCBP

Prerequisites / notice
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/CSCBP
A. Oxenius, L. Eberl, H.M. Fischer, D. Adjiashvili, M. Kopf

Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

Updated handouts will be provided during the class.

Concepts in Modern Genetics, D. Bopp, A. Hajnal, J. Piel, M. Pilhofer

Introduction into structural and functional aspects of the immune system.

This course focuses on the concepts of classical and modern genetics and genomics.

Current literature references will be provided during the lectures.

Introduction to Mathematical Optimization

The goal of the course is to obtain a good understanding of some of the most fundamental mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems. The students will also practice applying the learned models to problems in engineering.

Methods of Computer Science

Introduction to basic techniques and problems in mathematical optimization, and their applications to problems in engineering.

The topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).
- Modelling with mathematical optimization: applications of mathematical programming in engineering.

Information about relevant literature will be given in the lecture.

This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

Methods of Computer Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0057-00L</td>
<td>Theoretical Computer Science</td>
<td>W</td>
<td>8</td>
<td>4V+2U+1A</td>
<td>J. Hromkovic</td>
</tr>
</tbody>
</table>

Concepts to cope with: a) what can be accomplished in a fully automated fashion (algorithmically solvable) b) How to measure the inherent difficulty of tasks (problems) c) What is randomness and how can it be useful? d) What is nondeterminism and what role does it play in CS? e) How to represent infinite objects by finite automata and grammar?

Learning the basic concepts of computer science along their historical development.
This lecture gives an introduction to theoretical computer science, presenting the basic concepts and methods of computer science in its historical context. We present computer science as an interdisciplinary science which, on the one hand, investigates the border between the possible and the impossible and the quantitative laws of information processing, and, on the other hand, designs, analyzes, verifies, and implements computer systems.

The main topics of the lecture are:
- alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks
- finite automata, regular and context-free grammars
- Turing machines and computability
- complexity theory and NP-completeness
- design of algorithms for hard problems

This lecture is covered in detail by the textbook "Theoretical Computer Science".

Further reading:

More exercises and examples in:
6. A. Asteroth, Ch. Baier: Theoretische Informatik

Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature

Prerequisites / notice
During the semester, two non-obligatory test exams will be offered.
Content

1. Direct Methods for linear systems of equations
2. Least Squares Techniques
3. Data Interpolation and Fitting
4. Filtering Algorithms
8. Approximation of Functions
9. Numerical Quadrature
10. Iterative Methods for non-linear systems of equations
11. Single Step Methods for ODEs
12. Stiff Integrators

Lecture notes

Lecture materials (PDF documents and codes) will be made available to participants:

Lecture Git repository: https://gitlab.math.ethz.ch/NumCSE/NumCSE
Tablet classroom notes: http://www.sam.math.ethz.ch/~grsam/HS16/NumCSE/NCSE16_Notes/
Lecture recording: http://www.video.ethz.ch/lectures/d-math/2016/autumn/401-0663-00L.html
Homework problems: https://people.math.ethz.ch/~grsam/HS16/NumCSE/NCSEProblems.pdf

Literature

M. Hanke-Bourgeois “Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens”, BG Teubner, 2002

Prerequisites / notice

The course will be accompanied by programming exercises in C++ relying on the template library EIGEN. Familiarity with C++, object oriented and generic programming is an advantage. Participants of the course are expected to learn C++ by themselves.

Uncertainty Quantification for Engineering & Life Sciences

Number of participants limited to 60.

Abstract

Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective

The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content

Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature

1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice

The course will be accompanied by programming exercises in C++ relying on the template library EIGEN. Familiarity with C++, object oriented and generic programming is an advantage. Participants of the course are expected to learn C++ by themselves.

Applications (Research Projects)

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<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>262-0500-00L</td>
<td>Lab Rotation in Experimental Biology</td>
<td>O</td>
<td>3</td>
<td>6A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>Flexible, short research project (lab rotation) with an emphasis on experimental biology. The course provides a practical overview of an experimental biology research area, applying concepts taught in the General and Core courses, and preparing for further specialization through the Master thesis.</td>
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<td>Objective</td>
<td>Flexible, short research project (lab rotation) with an emphasis on experimental biology. The course provides a practical overview of an experimental biology research area, applying concepts taught in the General and Core courses, and preparing for further specialization through the Master thesis.</td>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>262-0600-00L</td>
<td>Lab Rotation in Computer Science</td>
<td>O</td>
<td>3</td>
<td>6A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>Flexible, short research project (lab rotation) with emphasis on computer science/theory The course provides a practical overview of a computer science research area, applying concepts taught in the General and Core courses, and preparing for further specialization through the Master thesis.</td>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>262-0700-00L</td>
<td>Lab Rotation in Bioinformatics</td>
<td>O</td>
<td>3</td>
<td>6A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>Flexible, short research project within the field of computational biology/bioinformatics. The course provides a practical overview of a bioinformatics research area, applying concepts taught in the General and Core courses, and preparing for further specialization through the Master thesis.</td>
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<tr>
<td>Objective</td>
<td>Flexible, short research project within the field of computational biology/bioinformatics (can be chosen within any department participating in the CBB-Master). The course provides a practical overview of a bioinformatics research area, applying concepts taught in the General and Core courses, and preparing for further specialization through the Master thesis.</td>
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</table>

Prerequisites / notice

Fundamentals of Probability, Fundamentals of Computational Modeling

GESS Science in Perspective

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses

ETH/UZH
### Master's Thesis

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>262-0800-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

**Abstract**
The Master Thesis is the result of an independent scientific research and/or constructive development project in the chosen area of specialization.

**Objective**
The Master thesis concludes the Master programme. By writing up the Master thesis, students show their ability to independently produce a coherent and scientific piece of work.

**Content**
The program concludes with a Master thesis of 6 months duration that includes a written report and an oral presentation. The topic of the thesis can be chosen according to the student's interests in the field of computational biology & bioinformatics.

### Course Units for Additional Admission Requirements

**The courses below are only available for MSc students with additional requirements.**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0002-AAL</td>
<td>Data Structures and Algorithms</td>
<td>E-</td>
<td>7</td>
<td>15R</td>
<td>P. Widmayer</td>
</tr>
</tbody>
</table>

**Abstract**
This course is about fundamental algorithm design paradigms (such as induction, divide-and-conquer, backtracking, dynamic programming), classic algorithmic problems (such as sorting and searching), and data structures (such as lists, hashing, search trees). The connection between algorithms and data structures is explained for geometric and graph problems.

**Objective**
An understanding of the design and analysis of fundamental algorithms and data structures.

### Additional Admission Requirements

**Course Units for Additional Admission Requirements**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0242-AAL</td>
<td>Analysis II</td>
<td>E-</td>
<td>7</td>
<td>15R</td>
<td>M. Akveld, C. Busch</td>
</tr>
</tbody>
</table>

**Abstract**
Mathematical tools of an engineer.

**Objective**
Mathematics as a tool to solve engineering problems, mathematical formulation of problems in science and engineering. Basic mathematical knowledge of an engineer.

**Content**

**Literature**
- J. Stewart: Multivariable Calculus, Thomson Brooks/Cole
- V. I. Smirnov: A course of higher mathematics. Vol. II. Advanced calculus
- M. Akveld, R. Sperb, Analysis II, vdf
- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag

- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag

**406-0603-AAL**

**Stochastics (Probability and Statistics)**

**Abstract**
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.
Objective
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content
From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student’s t Distribution
Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

Literature
- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435
  From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/

Computational Biology and Bioinformatics Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

| V  | lecture          | P  | practical/laboratory course         |
| G  | lecture with exercise | A  | independent project                |
| U  | exercise          | D  | diploma thesis                     |
| S  | seminar           | R  | revision course / private study     |
| K  | colloquium        |    |                                      |

ECTS European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
Subjects of Specialization

Subjects are to be chosen from the courses offered in the master degree program in electrical engineering and information technology. The director of studies decides on exceptions, upon consultation with the tutor.

Course offer from the Master Program in Electrical Engineering and Information Technology

Diploma Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences</td>
<td>E-</td>
<td>0 credits</td>
<td></td>
<td>J. Leuthold</td>
</tr>
</tbody>
</table>

Abstract

The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

Objective

Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

Content

* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the Art, the “in this paper” paragraph, the scientific part, the summary, Equations, Figures).

* Topic 2: Power Point Presentations.

* Topic 3: Citation Rules and Citation Software.

* Topic 4: Guidelines for Research Integrity.

Literature

ETH “Citation Etiquette”, see www.plagiate.ethz.ch.


Prerequisites / notice

Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

227-3001-00L Diploma Thesis

Only for DAS in Information Technology and Electrical Engineering.

Registration for the diploma thesis requires the successful completion of 18 credits ECTS from subjects of specialization.

Abstract

The Diploma of Advanced Studies finishes with a 3-months diploma thesis which is directed by a professor of the department ITET. Students prove their ability to conduct independent scientific research on a specific research problem, using skills and knowledge acquired during the program. The thesis includes a written report and an oral presentation.

Objective

see above

DAS in Information Technology and Electrical Engineering - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>853-0063-02L</td>
<td>Military History I (without Exercises)</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>M. Olsansky</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
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<tr>
<td></td>
<td>The purpose of the lecture is to outline the development of the armed forces (assets regarding manpower, technology and armament), the concepts of warfare and the actual warfare in the 19th and 20th century.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>- Distinguish between military history as a subject and historiography as a way of describing events;</td>
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<td></td>
<td>- Analyse the modern developments regarding armed forces and warfare in the context of socio-economic changes;</td>
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<td></td>
<td>- Based on the approach regarding revolution in military affairs, describe the evolution of the armed forces and of warfare;</td>
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<td></td>
<td>- Exemplify the issues regarding the evolution of the combat (First and Second World War, Vietnam War and Algerian War).</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<td></td>
<td>The lecture first examines the bases of the science of (military) history. It focuses on how military history developed from war history, on specific similarities and differences between military history and general historiography, the different ways of dealing with history in Switzerland, Germany, France and in the Anglo-Saxon cultural area (different approaches) as well as on institutions which deal with military history such as universities, military academies, national and international commissions and associations etc.</td>
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<td>The lecture is structured along the lines of the concept of &quot;Military Revolution&quot; and starts with the formation of modern, European armed forces after the Oranian Army reform in the 17th century.</td>
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<td></td>
<td>Based on the &quot;Military Revolution&quot; approach, the lecture examines the structural changes regarding the armed forces and the development of warfare from the 18th to the 20th century. Special emphasis will be put on how the battlefield was revolutionized due to the Napoleonic wars, the industrialization in the 19th century, the First World War, the mechanization and totalization during the Second World War and the period of the Cold War.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<tr>
<td>853-0047-00L</td>
<td>World Politics Since 1945: The History of International Relations</td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>A. Wenger</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>This lecture series provides students with an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>By the end of the semester, participants should have a solid knowledge of the history and theoretical foundations of International Relations since the end of the Second World War.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>of &quot;Diploma Supplement&quot;</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
<td></td>
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<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>The lecture is being supported by a website on Moodle. If you have any questions, please contact Lukas Meyer; <a href="mailto:lukas.meyer@ispo.geis.ethz.ch">lukas.meyer@ispo.geis.ethz.ch</a>.</td>
</tr>
<tr>
<td>853-0082-00L</td>
<td>Strategic Studies I</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>M. Mantovani</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>The lecture series treats high-impact theories of strategic studies from antiquity to the present.</td>
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<td>The participants know in what ways the understanding of strategy has evolved over time.</td>
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<td>They understand the balance of strategy's basic components: ends, ways and means.</td>
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<td></td>
<td>They know the most important classics of strategy and war theory, especially against their specific background.</td>
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<td>Based on the analysis of historical and contemporary examples, they are aware of the ambiguity of declaration and implementation of strategies.</td>
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<td>They are capable of analyzing critically original texts and modern scholarly works in the field of strategic studies.</td>
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<td></td>
<td><strong>Content</strong></td>
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<td></td>
<td>The two-term lecture series treats classic texts of strategic studies from antiquity to the present. Term 1 covers the theories up until roughly 1900, term 2 the theories ever since.</td>
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<td>Theories are deemed classic, if they were prominent in their respective times and if they had a strong reception after, be it in literature, in academic debates or as guidelines for action. Each out of some 50 theories is discussed in three steps: historical context, core messages and reception.</td>
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</tr>
<tr>
<td></td>
<td><strong>Literature</strong></td>
<td></td>
<td></td>
<td></td>
<td>Peter Paret, Makers of Modern Strategy. From Machiavelli to the Nuclear Age, Princeton 1986</td>
</tr>
<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
<td></td>
<td></td>
<td></td>
<td>Martin van Creveld, A History of Strategy: from Sun Tzu to William S. Lind, Kouvola 2015</td>
</tr>
<tr>
<td>853-0037-01L</td>
<td>Military Psychology and Pedagogy I (without Exercises)</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>H. Annen</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Examine the fundamentals of the two sciences and establish links with military life. Discuss various schools of thought in psychology and focus on content and process theories of motivation. Explore characteristics of pedagogical thinking and discuss the values of military education with reference to the young adult serving in the armed forces.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>- Becoming acquainted with basic psychological views of human behaviour and experience</td>
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<td></td>
<td>- Knowing content- and process theories of motivation and being able to transfer them to the military context</td>
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<td></td>
<td>- Knowing the possibilities and limitations of military education and deriving consequences</td>
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</table>

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Data: 06.11.2018 12:57  Autumn Semester 2016  Page 401 of 1571
Overall, the objective is to become acquainted with the basics of both scientific areas and to make references to military practice. Military psychology is a branch of applied psychology; consequently selected aspects of psychological principles will be covered. Military pedagogy hasn't yet established itself firmly as an independent scientific discipline, it nevertheless can draw on a deep-seated tradition in Switzerland. Thus, the great importance that has been attached to the discussion of education in Swiss society and academia will be taken into account.

### Content

- History of military psychology
- Psychological images of humanity (psychoanalysis, behaviourism, behavioural biology, humanistic psychology, cognitivism)
- Motivational theories
- Defence-, service-, operational- and combat motivation
- Swiss military pedagogy
- Education as defining feature of pedagogic thinking and acting

### Literature

- Annen, H., Steiger, R. & Zwygart, U.: Gemeinsam zum Ziel, Huber, Frauenfeld 2004 (provided as pdf)
- Stadelmann, J.: Führung unter Belastung, Huber, Frauenfeld 1998 (provided as pdf)

The lecture is supported by a virtual learning environment containing relevant documents (presentations and texts) and information to further literature.

### 853-0064-00L Military Sociology I

#### Abstract
Beside of the most important terms of sociology, demographic changes and the related value and structure change will be analysed. The second part focuses on organizational sociology. Thirdly, the course examines to which extent armed forces can be considered as organizations like any other and to which extent they constitute a special case from an organizational and normative point of view.

#### Objective
Recognize and explain current changes (social change) in modern society (individualisation, pluralisation); describe demographic changes in Switzerland; explain the structures of societies; define issues and fields of research in modern military sociology and explain the foundations of organisational sociology; explain the military in terms of organisational sociology and identify specific traits of the military as an organisation.

#### Content
Societal change; organizations as societal phenomena; aims, structures, environments of organizations; specifics of the military as an organization; impacts of technological and societal changes on the armed forces in modern societies.

#### Literature
A reader with a set of texts will be handed out.

### 853-0064-00L Learning Environments for Training: Planning, Operation, Assessment

#### Abstract
In this lecture practical aspects of learning environments directed to training with respect to planning, operation and assessment are introduced comprising (a) presentations about their theoretical background, (b) discussions of practical aspects and (c) practical exercises.

#### Objective
The participants have the knowledge and skills necessary for planning, preparing, and implementing good lessons. They apply their knowledge adaptively and based on findings from the research on learning and instruction literature.

#### Content
The lecture consists of two parts: Basics of Learning skills and military didactics. The first part comprises insights in teaching and learning research, performance assessment, knowledge transfer and evaluation. Military didactics deals with specific aspects of military education:

- The planning of learning environments for schools and courses, the definition of learning objectives for military exercises, controlling and E-Learning within the army.

#### Lecture notes
The lecture comprises interactive parts where the participants elaborate and extend their knowledge and skills. There is no comprehensive written documentation of the lecture: the participants can download presentation slides, learning materials, and templates from "Moodle".

#### Literature
The necessary literature can be downloaded from "Moodle".

### 853-0033-00L Leadership I

#### Abstract
The lectures "Leadership I" (WS) and "Leadership II" (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. "Leadership I" covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

#### Objective
The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.

#### Prerequisites
The 1-hour written exam will take place during the last lecture in the semester.

### DAS Military Sciences - Key for Type

<table>
<thead>
<tr>
<th>Dr</th>
<th>Suitable for doctorate</th>
<th>W</th>
<th>Eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Recommended, not eligible for credits</td>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
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</table>

### Key for Hours

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<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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<tbody>
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<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

### ECTS

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
## Pharmacology and Toxicology I

**Number**: 535-0521-00L  
**Title**: Pharmacology and Toxicology I  
**Type**: W  
**ECTS**: 2 credits  
**Hours**: 2V  
**Lecturers**: U. Quitterer

**Abstract**: The two-semester lecture course will provide a detailed understanding of the fundamentals of drug action and the mechanisms of action and therapeutic use of the important classes of drugs. The lectures are intended for students of pharmaceutical sciences.

**Objective**: The lectures will provide a comprehensive survey of pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects.

**Content**: Topics include disease-relevant macroscopic, microscopic, pathobiochemical and functional disturbances of specific organs and organ systems. The lectures integrate disease pathology with mechanisms of drug action, usage, metabolism, pharmacokinetics, side effects, toxicology, contraindications and dosage of relevant drug classes. Basic principles of clinical pharmacology and pharmacotherapy will be covered.

**Lecture notes**: Für jede Vorlesung wird ein Skript abgegeben, das eine Zusammenfassung mit den wichtigsten Stichpunkten beinhaltet.

**Literature**:  
**Recommended reading**:  

**or**  
Heinz Lüllmann, Klaus Mohr, Lutz Hein, Martin Wehling  

**Comprehensive overview**:  

**The classic textbook in Pharmacology**:  

**Prerequisites / notice**  
Voraussetzungen: Abschluss Grundstudium

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## Clinical Microbiology

**Number**: 535-0165-00L  
**Title**: Clinical Microbiology  
**Type**: W  
**ECTS**: 1 credit  
**Hours**: 1V  
**Lecturers**: K. Lucke

**Abstract**: Thorough knowlegde of major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.

**Objective**: Thorough knowledge of all major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.

**Content**: Basics and principles of clinical microbiology:  
- host-pathogen interaction  
- symptoms and diagnosis of major bacterial pathogens  
- therapeutic regimens commonly used against bacterial disease  
- major aspects of medical mycology, virology and parasitology  
- epidemiology

**Literature**:  
- Brock, Mikrobiologie, Pearson, 13. aktualisierte Auflage  
- Kayser F. et al., Medizinische Mikrobiologie, Thieme, Stuttgart, New York

**Prerequisites / notice**  
Voraussetzungen: Abschluss Grundstudium

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## Gene Technology

**Number**: 535-0810-00L  
**Title**: Gene Technology  
**Type**: W  
**ECTS**: 2 credits  
**Hours**: 2G  
**Lecturers**: D. Neri

**Abstract**: The course will provide a solid overview of the science and issues in gene technology and its pharmaceutical applications.

**Objective**: The aim of the lecture course is to provide a solid overview of gene technology, with a special focus on drug development. Topics: Antibody phage technology, DNA-encoded chemistry, protein modification technology, genome sequencing, transcriptomics, proteomics, functional genomics, principle of drug discovery. The course is suited for advanced undergraduate and early graduate students in pharmaceutical sciences or related fields.
Content

1. Antibody phage technology
   - The antibody molecule
   - V genes, CDRs, basics of antibody engineering
   - Principles of phage display
   - Phagemid and phage vectors
   - Antibody libraries
   - Phage display selection methodologies
   - Other phage libraries (peptides, globular proteins, enzymes)
   - Alternative screening/selection methodologies
   - DNA-encoded chemical libraries

2. Proteins: chemical modification and detection of biomolecular interactions
   - Homo- and hetero-dimerization of proteins
   - Chemical modifications of proteins
   - Antibody-drug conjugates
   - Radioactive labeling of proteins
   - Kinetic association and dissociation constants
   - Affinity constant: definition and its experimental measurement

3. Genomics: Applications to Human Biology
   - Protein cloning and expression
   - DNA sequencing
   - Some foundations of genetic analysis
   - Knock-out technologies
   - Transcriptomics
   - Proteomics
   - Recombinant vaccines

4: Pharmaceuticals: Focus on Discovery
   - Ligand Discovery
   - Half-life extension
   - Cancer therapy
   - Gene therapy

Lecture notes

Skript "Gene Technology" by Prof. Dario Neri and slides of the lecture

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0830-00L</td>
<td>Pharmaceutical Immunology</td>
<td>2</td>
<td>W</td>
<td>D. Neri, C. Halin Winter</td>
</tr>
<tr>
<td>535-0421-00L</td>
<td>Galenical Pharmacy I</td>
<td>2</td>
<td>W</td>
<td>J.C. Leroux, B. A. Gander</td>
</tr>
<tr>
<td>535-0250-00L</td>
<td>Biotransformation of Drugs and Xenobiotics</td>
<td>1</td>
<td>V</td>
<td>S.D. Krämer</td>
</tr>
</tbody>
</table>

Abstract

Get Students familiar with basic Immunological concepts of pharmaceutical relevance.

Objective

Get Students familiar with basic Immunological concepts of pharmaceutical relevance.

Content

Chapters 1 - 11 of the Janeway's ImmunoBiology, by Kenneth Murphy (9th Edition; Garland).

Literature

Janeway's ImmunoBiology, by Kenneth Murphy (9th Edition).

Paperback [www.garlandscience.com]

Abstract

Principles and technologies for the manufacturing of dosage forms and drug delivery systems. Knowledge of pharm. excipients, materials, containers, liquid and semi-solid dosage forms, their production, function, quality and application. Comprehension of molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in dosage forms.

Objective

Knowledge of the most important pharmaceutical excipients, materials, containers, liquid and semi-solid dosage forms, of their production, function, quality, stability and application. Comprehension of the molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in disperse dosage forms.

Content

Introduction and overview of important fundamentals, principles and technologies for the development and manufacturing of dosage forms and drug delivery systems. Overview of the most important pharmaceutical excipients and polymers, their structure, properties and processing; importance of materials properties for containers. Pharmaceutical solvents, fundamentals of solubility and solubilization of drugs. Water treatment processes, sterilization techniques and quality requirements of pharmaceutical water. Parenteral dosage forms and liquid ophthalmics. Surfactants, micel formation and colloidal systems. Liquid suspensions and emulsions. Stabilization measures in dosage forms.

Literature

C.-D. Herzfeld und J. Kreuter (Hrsg.) Grundlagen der Arzneiformenlehre, Springer Verlag, Berlin 1999

H. Leuenberger (Hrsg.) Physikalische Pharmazie, Wissenschaftliche Verlagsgesellschaft, Stuttgart 2002


R. Voigt, Pharmazeutische Technologie, 10. Auflage, Deutscher Apotheker Verlag, Stuttgart, 2006


Prerequisites / notice

Language: German and English

Prerequisites:

Language: German and English

Abstract

Knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.

Objective

Knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.

Content

Major reactions of biotransformation. Major enzymes and reaction partners involved in the biotransformation of drugs and xenobiotics.

Lecture Notes

Biotransformation of drugs and xenobiotics
Introduction to the principles, methods, and applications of pharmacoepidemiology and drug safety. Drug safety in the pharmaceutical industry and regulatory authorities, but also for hospital and office pharmacists. Another focus is the evaluation and interpretation of pharmacoepidemiological drug safety studies in the medical literature and the evaluation of benefits vs. risks.

- To familiarize participants with the principle methods and applications of pharmacoepidemiology and drug safety that is relevant for industry, regulatory affairs, but also for clinical pharmacists in hospitals and office pharmacies.
- Perform independently a causality assessment of suspected adverse drug reactions in patients
- Study designs and biostatistics used for the quantitative evaluation of drug safety
- Setup of programs that can effectively reduce medication errors and improve drug safety in clinical practice, particularly in hospitals

Historical landmarks of drug safety
Pharmacovigilance and causality assessment
Drug safety in premarketing clinical trials
Descriptive, cohort and case-control drug safety study designs; Data analysis and control of confounding
Pharmacoepidemiology and regulatory decision making in drug safety; Risk management plans (RMPs)
Medication errors, clinical pharmacology / clinical pharmacy
Clinical Decision Support Systems, Interventional Pharmacoepidemiology
Pharmacoepidemiological databases, 'Big Data'
Interactive discussion of many real-life examples for each topic

This course will be a combination of formal lectures, group discussions and self-directed studies. Course material will be taught through seminars, case studies in small groups.

Reading material and scripts will be provided for each week.

Recommended literature
- Rothman: Introduction to Epidemiology
- Strom, Kimmel, Hennessy: Textbook of Pharmacoepidemiology

In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed. Furthermore, students will expand their training in pharmaceutical immunology and will be introduced to the basic concepts of pharmaceutical product quality management.

- Students know and understand:
  - basic mechanisms and regulation of the immune response
  - the pathogenic mechanisms of the most important immune-mediated disorders
  - the most frequently used expression systems for the production of therapeutic proteins
  - the use of protein engineering tools for modifying different features of therapeutic proteins
  - the mechanism of action of selected therapeutic proteins and their application
  - basic concepts in the GMP production of therapeutic proteins

The course consists of two parts:

In a first part, students will complete their training of pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenic mechanisms of immune-mediated diseases. Deepened knowledge of immunology will be relevant for understanding the mechanism of action of many therapeutic proteins, as well as for understanding one major concern related to the use of protein-based drugs, namely, immunogenicity.

The second part focuses on topics related to the development and application of therapeutic proteins, such as protein expression, protein engineering, reducing immunogenicity, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.

Handouts to the lectures will be available for downloading under http://www.pharma.ethz.ch/scripts/index
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

The course is divided into two parts. The first part provides a detailed understanding of drugs and pharmacotherapy of infectious diseases and cancer. The second part gives an overview of the field of pharmacogenomics with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.

The course advances basic knowledge in pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects of drug therapy in the field of infectious diseases and cancer. The course also provides an overview of the field of pharmacogenomics, with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.

Topics include the pharmacology and pharmacotherapy of infectious diseases and cancer. In the field of pharmacogenomics, the course is focused on genetics, genome-wide association studies, genetic disease predisposition, examples of genetic variability of drug metabolism and drug responses, identification of new drug targets, relevance of pharmacogenomics for clinical drug development, and toxicogenomics.

A script is provided for each lecture course. The scripts define important and exam-relevant contents of lectures. Scripts do not replace the lecture.

Recommended reading:
The classic textbook in Pharmacology:
Goodman and Gilman’s The Pharmacological Basis of Therapeutics
Laurence Brunton, Bruce Chabner, Bjorn Knollman.
12th edition - 1808 pages

or
Klaus Aktories, Ulrich Förstermann, Franz Hofmann, Klaus Starke.
Allgemeine und spezielle Pharmakologie und Toxikologie.
11th edition - 1216 pages
2013; Urban & Fischer (Elsevier, München)
Overview of the most important clinical pictures: symptoms, recognition, differentiation, pharmacotherapy for the most important general and special medical indications. Groups of pharmaceutical compounds, active pharmaceutical ingredients, proprietary medicinal products: mechanisms of action, contraindication, therapeutic patterns, side effects, interactions.

Students have a thorough knowledge of all clinical pictures and their symptoms regarding outpatient treatment. They know the main groups of indications including active pharmaceutical self-medication and ingredients, mechanisms of action, pharmacokinetics, pharmacodynamics and dosage. They are also able to identify the relevant side effects and interactions.

Pathophysiology of selected clinical pictures and their main symptoms and clinical parameters. Recognition of alarm symptoms and distinction between pharmaceutical self-medication and the need for medical treatment. Detailed coverage of the pharmacotherapy of all fields of indication encountered in outpatient treatment. Outlining of therapeutic strategies and patterns with regard to suitable pharmaceutical compounds, active pharmaceutical ingredients and representative range of proprietary medicinal products. Discussion of the most important mechanisms of action, contraindications, side effects and interactions.

Hands-on course in pharmaceutical manufacturing in the pharmacy according to “GMP regulations for small quantities” defined in the pharmacopoeia: Design and practical approach in compounding of formulas using the most important dosage forms including their risks and quality assurance.

Students are able to manufacture, to package, to quality-control and document pharmaceutical compounding on their own, “best practice” and according to GMP regulations, using the appropriate techniques. They know the most important properties of active ingredients and excipients frequently used. They achieve the necessary knowledge including the relevant literature and other sources of information, as well as the legal requirements regarding pharmaceutical manufacturing in small quantities.

To impart knowledge about the main techniques and processes in the manufacturing of pharmaceuticals in small quantities (formulas), focusing on the design, manufacturing, quality assurance and risk based self-appraisal including the patient specific dispensing. During the practical training periods: by means of pharmacologically relevant examples (e.g. the planning, the manufacturing including the correct use of the equipment, the in-process control, the packaging and the quality assurance are practiced for various dosage forms and recipes. Quality assurance and control are mainly risk adapted considering as well hygiene regulations according to current pharmaceutical practice. The participants will thus improve their general GMP knowledge and skills.

Organisation of institutional environments (emergency hospitals), with special focus on the medication process and institutional environment. They are able to find the necessary information and deal with problems in connection with pharmaceuticals, to evaluate them and to communicate and documentate their findings adequately. They know how a hospital is organised (procedures, possible problems), responsibilities of the different members of the staff and, most importantly, what the function of a hospital pharmacy is.

Principals of the organisation of institutional environments (emergency hospitals), with special focus on medication processes and institutional pharmaceutical care (circuitation of medication, continuum of care). Hygiene regulations, medical products, applications, drug formularies, patient files, SOAP notes, kardex study. Participation at interdisciplinary visits, internal trainings and doctors’ reports as well as visitation of the emergency room. Drug interaction, generic substitution, quality management and pharmacovigilance.

Introduction to managed care systems (Pharmaceutical Care und Public Health): problems with regard to therapy and approaches to solutions, service, first aid and medicinal products. Methods of illness prevention and health promotion. Important additional assortments including complementary medicine. Law and economy in everyday pharmacy, structures of the national health care system.

Students know the most important concepts and methods of pharmaceutical care of patients with regard to OTC and Rx-only drugs as well as the essential concepts and methods of public health, prevention and health care. They master the basic rules concerning the pharmaceutical triage and their implications. For the clinical pictures covered during the course, they are able to make therapeutic plans or accompany and optimize doctor’s orders. Students show an adequate understanding of the rights and duties of pharmacists as medical personnel, regarding medical care in the framework of the Swiss health care system. They are capable of handling important medical products and instructing patients about their use. Students have the necessary basic skills and applications of first aid and emergency medicine. They know the essence, chances and limits with reference to additional assortments, therapeutic options like phytotherapy, complementary medicine, veterinary pharmacy and non-medicinal methods of healing. Students have the essential knowledge of legal aspects and regulations concerning pharmacists and know the basics of business administration.

Data: 06.11.2018 12:57
Autumn Semester 2016
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### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>G</th>
<th>U</th>
<th>S</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>lecture</td>
<td>lecture with exercise</td>
<td>exercise</td>
<td>seminar</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>A</td>
<td>D</td>
<td>R</td>
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<tr>
<td>practical/laboratory course</td>
<td>independent project</td>
<td>diploma thesis</td>
<td>revision course / private study</td>
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</table>

ECTS  European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>064-0003-16L</td>
<td>Postgraduate Colloquium on the History of Art and Architecture</td>
<td>W</td>
<td>3</td>
<td>2K</td>
<td>to be announced</td>
</tr>
<tr>
<td>Abstract</td>
<td>The Postgraduate Colloquium mainly addresses doctoral students of the Chair. It is aimed at presenting and further discussing the current research, thus focusing on the argumentation and verification of contextual and methodical questions. The Colloquium provides a basis for exchange and further education and to establish and promote networking.</td>
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<tr>
<td>Objective</td>
<td>The Colloquium focuses on the presentation and further discussion of the current research of doctoral students. It concentrates on the discussion and verification of contextual and methodical questions and provides a basis for exchange and networking among the participants.</td>
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<tr>
<td>Content</td>
<td>Die Themenschwerpunkte der jeweiligen Veranstaltung richten sich nach den präsentierten Forschungsarbeiten. Inhaltlich korrespondieren sie mit den Forschungsschwerpunkten der Professur.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Mehrtägiges Kolloquium. Veranstaltungszeit und -ort nach Vereinbarung.</td>
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<tr>
<td>Abstract</td>
<td>The development of the material is conceived as a joint form-finding process. The basic idea is to create a revue-like series of various &quot;numbers&quot;: a dynamic mixture of book and lecture texts, historical documents and spontaneously evolving conversations. The final product will be performed by workshop contributors during the anniversary celebrations.</td>
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<tr>
<td>Objective</td>
<td>The motivation behind the workshop is to focus on the beginnings of the gta on the occasion of its 50th anniversary. Among the founding fathers there were fascinating protagonists such as Adolf Max Vogt, Bernhard Hoesli, and Paul Hofer. Based on an understanding of their concepts, methods, and ideas, a text collage will culminate in a script for a one-hour-long performance reading. In addition to the graphically significant gta publications produced at this time (&quot;Rainbow&quot;: books), contemporary image and film materials can be integrated as well as interviews with contemporary witnesses and the present gta chair. The result intends both contextualization as well as critical revision.</td>
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<tr>
<td>Content</td>
<td>The seminar addresses the fellows of the Doctoral Program in History and Theory of Architecture. All other doctoral students of the Faculty of Architecture are welcome.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Space is limited and participation is subject to approval from the organizers.</td>
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<tr>
<td>064-0009-16L</td>
<td>Research Colloquium in Architecture and Urbanism (M.Angélil)</td>
<td>W</td>
<td>3</td>
<td>1K</td>
<td>M. Angélil</td>
</tr>
<tr>
<td>Abstract</td>
<td>This colloquium is open to doctoral candidates in fields related to Architecture and Urbanism. Its focus will be on contemporary topics in urbanism and will involve two or three one-day sessions over the course of the semester, each of which will be attended by an invited scholar.</td>
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<tr>
<td>Objective</td>
<td>The sessions will involve brief presentations of dissertation work by the participants followed by discussions with the guests.</td>
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<tr>
<td>Content</td>
<td>This colloquium is open to doctoral candidates in fields related to Architecture and Urbanism. Its focus will be on contemporary topics in urbanism and will involve two or three one-day sessions over the course of the semester, each of which will be attended by an invited scholar.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Languages: German and English</td>
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<tr>
<td>064-0013-16L</td>
<td>Methods in the History and Theory of Architecture</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>I. Heinze-Greenberg</td>
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<tr>
<td>Abstract</td>
<td>Introduction to methodological approaches in the history and theory of architecture; presentation and discussion of individual doctoral projects.</td>
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<tr>
<td>Objective</td>
<td>The doctoral students analyze critically relevant approaches in the history and theory of architecture and discuss fundamental questions with regard to their individual research projects, to produce and hand in their proposals.</td>
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<tr>
<td>Content</td>
<td>The two-semester course in the first year of the doctoral program in the history and theory of architecture has a twofold objective: First, reading sessions on central approaches in the history and theory of architecture provide a methodological basis for the a doctorate at the Institute gta. Secondly, by both, reading sessions and presentation and discussion sessions on the individual research projects, the doctoral students get support in the production of the proposal which they work on and which they have to present after the first year.</td>
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<tr>
<td>Prerequisites / notice</td>
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<tr>
<td>064-0015-16L</td>
<td>PhD Colloquium Theory of Information Technology for Architects</td>
<td>W</td>
<td>2</td>
<td>2K</td>
<td>L. Hovestadt</td>
</tr>
<tr>
<td>Abstract</td>
<td>Information technology plays an increasingly important role in research. To meet this challenging development, it is not only important to acquire respective skills, but also to consider and understand information technology in what sets it apart from other gestalts of technics (like mechanics, dynamics, or thermodynamics).</td>
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<tr>
<td>Objective</td>
<td>The aim of this colloquium is to counter an observable tendency, that proportional to the degree in which students master practical skills in computing, they increasingly submit uncritically, in their understanding and framing of problems, to the dictation of schemata and templates implemented by technical systems.</td>
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<tr>
<td>Content</td>
<td>The starting point for this colloquium is to comprehend computing not in terms of skills, but as a literacy which we can experience emerging today. Like in the case of writing as well, computing cannot be reduced to either logics, grammar, arithmetics, or analytics. Rather, computation, if comprehended as a literacy, relates to any of the established categories of learning and raises questions of an architectonic kind. This colloquium draws from the principal richness of cultural forms of knowing and learning and thematizes approaches to formulate a theoretical stance on information technology for architects which is driven by and resting on the actual reality of computability today. In this, it is complementary to those theory courses on technology offered by the historical disciplines at ETH.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>To benefit from this course, you should have a practical affinity to technics, as well as an abstract interest in information technology in its comprehensive cultural context.</td>
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<tr>
<td>Abstract</td>
<td>Advanced PhD candidates of urban studies, urban and landscape design and urban sociology report about their experiences and insights in the concrete application of methods utilized for their research and scientific publications. Discussion of ongoing individual work, methodological questions, critical perspectives on urban and landscape design and city's relation to society.</td>
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<tr>
<td>Objective</td>
<td>The seminar seeks to provide participants with a differentiated knowledge of methods in the field of the urbanism. Furthermore, it provides a platform to exchange contemporary urban research experiences across disciplinary boundaries, drawing from different geographies of knowledge production. Possible meta-themes include modes of data assessment in urban studies, ways of progressing from hypothesis to synthesis, and research by design as method.</td>
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</table>
The colloquium deals with the general problems, questions and methods of the interdisciplinary research field “The History of Knowledge”.

PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community. The colloquium is joint-organized by the chairs of Prof. Kees Christiaanse, Prof. Dr. Christian Schmid, Prof. Dr. Marc Angéli and Prof. Hubert Kumpner as one full-day event in the academic semester. The will comprise different formats, alternating with the responsible chair.

Participants in both cases will be expected to submit single-page abstracts of their papers in advance and to make a presentation of app. 20 minutes at the colloquium. The discussion rounds will be moderated by the organizing professor and the invited guests.

Enrolment on agreement with the lecturer only.

151-0906-00L
Frontiers in Energy Research

This course is only for doctoral students.

PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.

Knowledge of advanced research in the area of energy.

PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community. Every week there are two presentations, each structured as follows: 15 min introduction to the research topic, 15 min presentation of the results, 15 min discussion with the audience.

Lecture notes
Slides will be distributed.

Course Catalogue of ETH Zurich

862-0002-16L
Research Colloquium History of Knowledge (HS 2016)

only for MAGPW students, D-GEPP PhD and D-ARCH PHD students.

This colloquium is highly recommended for first and second semester MAGPW students.

The colloquium of the ZGW focuses on present developments, debates and perspectives in the field of history of knowledge. On the second and fourth date there will be public events in the Cabaret Voltaire.

The colloquium deals with the general problems, questions and methods of the interdisciplinary research field “The History of Knowledge”.

Knowledge has become one of the existential conditions of modern societies and it increasingly determines their dynamics. Therefore, it is getting more and more relevant to develop a differentiated understanding of the epistemic, social and cultural constraints of the production, circulation and the decay of knowledge. In addition, the colloquium asks after the cultural and ethical resonances of knowledge not only within science but also in relation to art, literature, technology, everyday life, and so on.

Prerequisites / notice
Short notice about program changes are possible and will be communicated through the ZGW newsletter. Please register with www.zgw.ethz.ch/de/newsletter.html

Credit points can be gained by regular attending and by writing an essay. In addition to the five colloquia there will be a deepening seminar on offer (lecturer K. Esphahangizi).

Free childcare available.

051-0827-16L
Sand: an (in)finite Resource? - Engineering for Development (E4D) Summer School

Number of participants limited.

The programme revolves around the depleting resource sand and the question of how to develop alternative building materials for future cities. The course is for 30 master and doctoral students from ETH Zurich and other academic institutions (from different disciplines related to the topic), joined by faculty members and external experts from fields of expertise related to the winter school topic.

The E4D summer school 2016 aims to develop an integrated vision to a global challenge of today’s construction industry. The programme revolves around the depleting resource sand and the question of how to develop alternative building materials for future cities. Led by different experts from around the world, students will not only learn the theoretical aspects of the subject matter but also gain insight into state-of-the-art applications and their research. The summer school presents different areas that could mobilise sand alternatives for construction and other applications: (i) Microbiologically Induced Calcite Precipitation (MICP), (ii) Chemical Crystallization Processes and (iii) 3D printing.

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The E4D summer school 2016 aims to develop an integrated vision to a global challenge of today’s construction industry. The programme revolves around the depleting resource sand and the question of how to develop alternative building materials for future cities. Led by different experts from around the world, students will not only learn the theoretical aspects of the subject matter but also gain insight into state-of-the-art applications and their research. The summer school presents different areas that could mobilise sand alternatives for construction and other applications: (i) Microbiologically Induced Calcite Precipitation (MICP), (ii) Chemical Crystallization Processes and (iii) 3D printing.

Sustainability is often referred to as an interaction of social, cultural, economic, and ecological aspects. In the construction industry sustainability has been perceived as the optimisation of existing material and energy uses, yet the fundamental energetic and material character of these base resources has not been questioned. The speed of consumption of these resources increases constantly due to demographic pressure and resulting construction, as seen around the world and in particular in developing and emerging countries. A fundamental understanding of metabolic processes is required to frame the question of material and energetic sustainability. At the same time the definition of resources expands to include previously undervalued materials and waste. Finally, advances in digital technology and science have opened new avenues for alternative materials and processes.

The summer school presents three areas that could mobilise sand alternatives for construction and other applications: I. Microbiologically Induced Calcite Precipitation (MICP); Also known as bio-cementation it is a process utilised in self-healing concrete and soil stabilisation. The application to sand will produce naturally grown structural sand bricks. This workshop will compare MICP for various sand types, building wastes and bacterial cultures.

II. Chemical Crystallization Processes: Based on material computation experiments pioneered by architect and engineer Frei Otto, this workshop combines form finding properties of sand with structural and thinking and chemical crystallization processes.

III. 3D Printing: 3D Printing with sand and building waste, finally, explores the potential of sand as a substrate within a binding agent. In combination with a robotic arm, 3D printing of sand is an in situ digitally controlled construction process. It overcomes the need for traditional form-work and transportation of material, thereby reducing the grey energy.
The relevance of STS in urban research is explored with three themes: problematizing, describing and assembling (cities). Participants will be required to enrol in one of three thematic groups, their stages of research may differ per group.

The objective of the summer school is to support PhD researchers in their individual research and specific research stages by sharing their work with keynotes and colleagues. Accordingly, participants are expected to develop their skills of articulating and communicating their ideas, examine various STS methods and techniques of approaching cities, and to discuss their research and obstacles in an academic setting. The three sessions; problematizing, describing and assembling, allow participants in various stages of their research to learn about the relevance of STS methodologies and concepts of urban research in general, and for their particular interest and research stage. They are also aimed at researchers not yet familiar with the approach and interested in learning a subset of its concepts (eg. networks/artefacts) and methodologies (e.g. ethnography/digital methods). Throughout the sessions participants will learn to; question the city from a STS perspective (problematizing), they will be introduced to the methodologies that tackle these questions (describing), and they will encounter ways of thinking through questions and answers (assembling). Specifically, participants are to write a full paper, design a poster and make a presentation. All deliverables will be evaluated by the keynote speakers, four external reviewers, and the organizers. The poster presentation will take place in front of a full audience, while paper presentations in the workgroup only. The organizers are inquiring for publishing opportunities of outstanding papers (eg. planNext from the AESOP YA, Contour at the EPFL or Spatium at the IAUS). The website will be updated with the posters and a review of following the event.

The summer school will open with an excursion to the housing project Hunzikerareal by the housing cooperative Mehr als wohnen in Zurich. This mixed-use area development is used as an illustration of how institutions, individuals and artefacts mediate the planning process towards an inclusionary and diverse process.

### Prerequisites

- Costs: CHF 500, including board and accommodation. All participants are responsible for organising and financing their own domestic or international travel to Delft, The Netherlands.
- The Engineering for Development (E4D) Winter School 2016 will invite 30 master and doctoral students from different disciplines related to the topic of the summer school. Applicants will be selected based on their academic record and previous work experiences. Applicants must send a one-page CV and one-page letter of motivation in PDF format stating their interest, to Ms. María Ubierna Aparicio (ubierna@fuu.baug.ethz.ch)
- Notification: 15 April 2016
- Deadline: 31 March 2016
- Taking place from 4 to 22 July 2016 at the TU Delft in The Netherlands.

### Abstract

In particular, the summer school addresses research exploring the borderlands of the diverse fields of STS and urban studies. It will be of particular interest to PhD candidates who have already begun their research and are in the stages before or after conducting field studies. As participants are required to enrol in one of three thematic groups, their stages of research may differ per group. In other words, the three themes can be interpreted to speak to various stages of research (problematizing, describing, and assembling respectively). The summer school is positioned at the intersection of science and technology studies (STS), urban studies and planning studies. The program emphasizes the development of conceptual and methodological insights as part of innovative approaches to contemporary urban phenomena. To the fields of urban studies it provides a more varied and dynamic conceptualisation of the city; it does not reduce urban phenomena to the logic of a capitalist mode of production. This endeavour relating urban studies with STS presents new, cross-cutting ways of examining arising planning issues.

Planning studies can benefit from new tools of interpreting problems of interconnection and expertise. The Assembling Cities summer school aims to bring together an interdisciplinary group of doctoral students who treat the city as their empirical site. Academic backgrounds include, but are not limited to: anthropology, architecture, geography, history, philosophy, political science, sociology, visual arts, and urban planning. In particular, the summer school addresses research exploring the borderlands of the diverse fields of STS and urban studies. It will be of particular interest to PhD candidates who have already begun their research and are in the stages before or after conducting field studies. As participants are required to enrol in one of three thematic groups, their stages of research may differ per group. In other words, the three themes can be interpreted to speak to various stages of research (problematizing, describing, and assembling respectively). The summer school is positioned at the intersection of science and technology studies (STS), urban studies and planning studies. The program emphasizes the development of conceptual and methodological insights as part of innovative approaches to contemporary urban phenomena. To the fields of urban studies it provides a more varied and dynamic conceptualisation of the city; it does not reduce urban phenomena to the logic of a capitalist mode of production. This endeavour relating urban studies with STS presents new, cross-cutting ways of examining arising planning issues.

Planning studies can benefit from new tools of interpreting problems of interconnection and expertise. A website will be created to advertise the summer school and will be distributed to various mailing lists (BESTS, EASST, s-architecture etc.) in our own networks and on posters at Swiss universities. It will be maintained until after the summer school in order to keep those interested and the participants informed about follow up activities.

### Content

The relevance of STS in urban research is explored with three themes: problematizing, describing and assembling (cities). Participants will be distributed in thematic groups, and lectures will be held by keynote speakers according to theme. Following the call, participants are required to indicate which theme fits their paper best as they will be shared within the thematic groups. The first day will include a keynote presentation followed by an informal poster session for each thematic group. The poster sessions are a chance for the other two groups to learn about participants' research and ask questions. The following day two sessions will be held with the support of the respective keynote.

During the first (morning) session the participants will present their papers (max 15 min) within their thematic groups followed by a general 20 min discussion. During this time, key points will be noted and later discussed in the second (afternoon) session in which each group will prepare a plenary discussion and presentation for the final day. The final day consists of a plenary discussion of each theme opened by the respective keynote and moderated by members of the thematic group. Each thematic group will summarize their discussions and findings in a final presentation. The framework for the discussion and presentations will be defined together with the keynotes and could be, for example, a specific question and/or obstacle, a clear toolbox, or excerpts from selected presentations related to each respective theme.

The summer school will open with an excursion to the housing project Hunzikerareal by the housing cooperative Mehr als wohnen in Zurich. This mixed-use area development is used as an illustration of how institutions, individuals and artefacts mediate the planning process towards an inclusionary and diverse project.

### Notification:

- Notification: 15 April 2016
- Deadline: 31 March 2016

### Eligibility:

- Eligible for credits and recommended
- Eligible for credits and recommended
- Eligible for credits and recommended

### Key for Hours:

- V: lecture
- G: lecture with exercise
- U: exercise
- S: seminar
- K: colloquium
- P: practical/laboratory course
- A: independent project
- D: diploma thesis
- R: revision course / private study

### Prerequisites:

- Special students and auditors need special permission from the lecturers.

### European Credit Transfer and Accumulation System (ECTS):

- European students and auditors need special permission from the lecturers.
### Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0906-00L</td>
<td><strong>Frontiers in Energy Research</strong>&lt;br&gt;This course is only for doctoral students.</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Mazzotti, R. S. Abhari, J. Carmeliet, M. Filippini</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Knowledge of advanced research in the area of energy.</td>
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<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community. Every week there are two presentations, each structured as follows: 15 min introduction to the research topic, 15 min presentation of the results, 15 min discussion with the audience.</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td>Slides will be distributed.</td>
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**Course Catalogue of ETH Zurich**

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>102-1227-16L</td>
<td><strong>Advanced Life Cycle Assessment (HS16)</strong>&lt;br&gt;<em>Students should be familiar with either life cycle assessment, environmental science, or economic modeling. This seminar is intended to be primarily for Ph.D. students.</em></td>
<td>W</td>
<td>2</td>
<td>4S</td>
<td>C. L. Mutel</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>The summer school examines in depth the systemic choices and assumptions used in life cycle assessment models of the world economy and biosphere, and then have the students apply this knowledge by making their own choices and building their own version of a life cycle inventory database. Software to apply these system modelling choices would be built specifically for the summer school.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>To improve ones understanding of life cycle assessment, and the broader issues in modeling, improving, and understanding sustainability assessments.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<tr>
<td></td>
<td>Students should be familiar with either life cycle assessment, environmental science, or economic modeling. This seminar is intended to be primarily for Ph.D. students.</td>
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### Doctoral Department of Civil, Environmental and Geomatic Engineering - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>Z</th>
<th>Courses outside the curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</table>

**ECTS**

European Credit Transfer and Accumulation System

*Special students and auditors need special permission from the lecturers.*
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1159-00L</td>
<td>Molecular Systems Biology</td>
<td>E</td>
<td>0</td>
<td>1K</td>
<td>U. Sauer, R. Aebersold</td>
</tr>
<tr>
<td>Abstract</td>
<td>Seminar series on current research topics in systems biology</td>
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<tr>
<td>Objective</td>
<td>An overview of systems biology research</td>
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</tr>
<tr>
<td>Content</td>
<td>Seminar series on current research topics in systems biology</td>
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<tr>
<td>Lecture notes</td>
<td>none</td>
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<tr>
<td>Literature</td>
<td>none</td>
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<tr>
<td>701-0265-00L</td>
<td>Ecology and Evolution</td>
<td>W</td>
<td>1</td>
<td>2S</td>
<td>E. Postma, J. Jokela</td>
</tr>
<tr>
<td>Abstract</td>
<td>A course dedicated to the reading and discussion of the relevant literature. The actual list of theme papers will be proposed anew for every year. Students then choose a topic and prepare themselves for a general discussion with their colleagues and peers. In the process, current and controversial topics will be discussed and studied.</td>
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<tr>
<td>Objective</td>
<td>To become proficient in reading scientific literature, to understand how to look at publications, to understand them and to be able to put them in context. The course also trains the skills needed for the presentation of scientific contributions and the ability to put things into a broader context. Training in how to participate in a scientific discussion, how to make an argument and how to listen to arguments of others.</td>
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<tr>
<td>Content</td>
<td>All topics focus on themes from ecology and evolution, notably so on studies on adaptation of organisms, their evolutionary history, or on questions of current methodology.</td>
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<tr>
<td>Literature</td>
<td>none</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The actual content, i.e. the theme papers, will be determined and allocated to the participants at the start of the course each year. Takes place at Uni Irchel. Please refer to notes on board or ask secretary Mrs. Rita Jenny (<a href="mailto:Rita.Jenny@env.ethz.ch">Rita.Jenny@env.ethz.ch</a>).</td>
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<tr>
<td>376-1791-00L</td>
<td>Introductory Course in Neuroscience I (University of Zurich)</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>J.M. Fritschy, W. Knecht</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course gives an introduction to human and comparative neuroanatomy, molecular, cellular and systems neuroscience.</td>
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<tr>
<td>Objective</td>
<td>The course gives an introduction to human and comparative neuroanatomy, molecular, cellular and systems neuroscience.</td>
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</tbody>
</table>
| Content      | 1) Human Neuroanatomy I&II  
2) Comparative Neuroanatomy  
3) Development I&II  
4) Membran and Action Potential  
5) Synaptic Transmission & Plasticity I&II  
6) Glia and Blood-Brain-BARRIER  
7) Somatosensory and Motor System  
8) Visual System  
9) Auditory System  
10) Circuits underlying Emotion  
11) Modeling of Neural Circuits |
| Prerequisites / notice | For doctoral students of the Neuroscience Center Zurich (ZNZ). |
| 376-1795-00L | Advanced Course in Neurobiology I (Functional Anatomy of the Rodent Brain) (University of Zurich) | W    | 2    | 2V    | J.M. Fritschy, H. U. Zeilhofer |
| Abstract     | The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience. |
| Objective    | For Doctorierende des Zentrums für Neurowissenschaften Zürich. Nicht für Master-Studierende geeignet. |
| Prerequisites / notice | Für Doktorierende des Zentrums für Neurowissenschaften Zürich. Nicht für Master-Studierende geeignet. |
| 151-0255-00L | Energy Conversion and Transport in Biosystems | W    | 4    | 2V+1U | D. Poulikos, A. Ferrari    |
| Abstract     | Theory and application of thermodynamics and energy conversion in biological systems with focus on the cellular level. |
Theory and application of energy conversion at the cellular level. Understanding of the basic features governing solutes transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to bioluidics. Heat and mass transport processes in the cell, generation of forces, work and relation to biomedical technologies.

Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation.

Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

Material in the form of hand-outs will be distributed.

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

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I. Ethics & the Process of Ethical Inquiry
---------------------------------------

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)
----------------------------------------------------------

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)


Abstract
About 5 talks on applied statistics.

Objective
See how statistical methods are applied in practice.
<table>
<thead>
<tr>
<th>Content</th>
<th>Prerequisites / notice</th>
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<tbody>
<tr>
<td>There will be about 5 talks on how statistical methods are applied in practice. This is not a lecture. There is no exam and no credit points will be awarded. The current program can be found on the web: <a href="http://stat.ethz.ch/events/zukost">http://stat.ethz.ch/events/zukost</a> Course language is English or German and may depend on the speaker.</td>
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### 551-1109-00L Seminars in Microbiology

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<tbody>
<tr>
<td>2K</td>
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<tr>
<td>M. Aebi, H.M. Fischer, W.D. Hardt, J. Piel, J. Vorholt-Zambelli</td>
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**Abstract**
Seminars by invited speakers covering selected microbiology themes.

**Objective**
Discussion of selected microbiology themes presented by invited speakers.

### 551-0030-01L Doctoral Thesis

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<td>Professors</td>
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**Abstract**
Doctoral Thesis

### 401-0620-00L Statistical Consulting

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<tr>
<td>M. Kalisch, L. Meier</td>
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**Abstract**
The Statistical Consulting service is open for all members of ETH, including students, and partly also to other persons.

**Objective**
Advice for analyzing data by statistical methods.

**Content**
Students and researchers can get advice for analyzing scientific data, often for a thesis. We highly recommend to contact the consulting service when planning a project, not only towards the end of analyzing the resulting data!

This is not a course, but a consulting service. There are no exams nor credits.

Contact: beratung@stat.math.ethz.ch . Tel. 044 632 2223. See also http://stat.ethz.ch/consulting

**Requirements:** Knowledge of the basic concepts of statistics is desirable.

### 551-0512-00L Current Topics in Molecular and Cellular Neurobiology

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<tr>
<td>U. Suter</td>
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</table>

**Abstract**
The course is a literature seminar or "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.

**Objective**
The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

**Content**
You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance.

You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).

**Lecture notes**
Presentations will be made available after the seminars.

**Prerequisites / notice**
You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).

**Course language is English or German and may depend on the speaker.**

### 551-0737-00L Experimental Ecology: Evolution and Ecology

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<tr>
<td>2S</td>
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<tr>
<td>S. Bonhoeffer</td>
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</table>

**Abstract**
Interaction seminar. Student-mediated presentations, guests and discussions on current themes in ecology, evolutionary and population biology.

**Objective**
Getting familiar with scientific arguments and discussions. Overview of current research topics. Making contacts with fellow students in other groups.

**Content**
Scientific talks and discussions on changing subjects.

**Lecture notes**
None

**Literature**
None

**Prerequisites / notice**
For information and details: http://www.eco.ethz.ch/news/zis or contact: Lehrer-eve@env.ethz.ch

### 551-0509-00L Current Immunological Research in Zürich

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<tbody>
<tr>
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</table>

**Abstract**
This monthly meeting is a platform for Zurich-based immunology research groups to present and discuss their ongoing research projects. At each meeting three PhD students or Postdocs from the participating research groups present an ongoing research project in a 30 min seminar followed by a plenary discussion.

**Objective**
The aim of this monthly meeting is to provide further education for master and doctoral students as well as Postdocs in diverse topics of immunology and to give an insight in the related research. Furthermore, this platform fosters the establishment of science- and technology-based interactions between the participating research groups.

**Content**
Presentation and discussion of current research projects carried out by various immunity-oriented research groups in Zurich.

**Lecture notes**
None

**Course Catalogue of ETH Zurich**

### Doctoral Department Biology - Key for Type

<table>
<thead>
<tr>
<th>W</th>
<th>O</th>
<th>Compulsory</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-</td>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>Dr</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
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</table>
### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System

  Special students and auditors need special permission from the lecturers.
Week 20

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract
This seminar will feature invited lectures about recent advances and developments in systems biology, including topics from biology, bioengineering, and computational biology.

Objective
To provide an overview of current systems biology research.

Content
The final list of topics will be available at http://www.bsse.ethz.ch/education/.

---

Week 20

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>636-0309-00L</td>
<td>Advances in Molecular Biotechnology</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>M. Fussenegger</td>
</tr>
</tbody>
</table>

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Doctoral Department of Biosystems Science and Engineering - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>Letter</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
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<td>diploma thesis</td>
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<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Introduction to the fundamentals of lasers and their applications with an emphasis on micro- and nano-structuring. Several applications which are still in the research state, will be discussed together with industrial applications, such as micro lithography and laser welding. Other aspects are the materials that are applied in these applications, e.g. photoresists, and their functioning.

**Abstract**

Introduction to the fundamentals of lasers and their applications with an emphasis on micro- and nano-structuring. Several applications which are still in the research state, will be discussed together with industrial applications, such as micro lithography and laser welding. Other aspects are the materials that are applied in these applications, e.g. photoresists, and their functioning.

**Content**

Introduction to lasers. Overview of micro- and nanotechnology, micro lithography, photoresists: classical types and new developments, laser cutting and welding, laser cleaning, laser ablation, polymer ablation: designed polymers, lasers and surfaces, laser spectroscopy, laser chemical vapor deposition, pulsed laser deposition (PLD), special materials by PLD, alternative structuring methods.

**Lecture notes**

The script (a copy of the slides) will be handed out during the first lecture.

**Literature**

- FSRM, CD-ROM: An Introduction to the World of Microsystems, Neuchatel.

**Doctoral Studies in Organic Chemistry**

**Number**

529-0270-00L

**Title**

Analytical Chemistry Seminar

**Type**

E-

**ECTS**

0 credits

**Hours**

1K

**Lecturers**

R. Zenobi, P. S. Dittrich

**Abstract**

Presentation and discussion of current research topics in analytical chemistry

**Objective**

Presentation and discussion of current research topics in analytical chemistry

**Content**

Analytical Chemistry Seminar

**Number**

529-0290-00L

**Title**

Organic Chemistry (Seminar)

**Type**

E-

**ECTS**

0 credits

**Hours**

2S

**Lecturers**

E. M. Carreira, J. W. Bode, F. Diederich, P. S. Dittrich, D. Hilvert, H. Wennemers, R. Zenobi

**Abstract**

Presentation and discussion of current research topics in analytical chemistry

**Objective**

Presentation and discussion of current research topics in analytical chemistry

**Content**

Organic Chemistry Seminar

**Number**

529-0299-00L

**Title**

Organic Chemistry

**Type**

E-

**ECTS**

0 credits

**Hours**

1.5K

**Lecturers**

J. W. Bode, E. M. Carreira, P. Chen, F. Diederich, P. S. Dittrich, D. Hilvert, H. Wennemers, R. Zenobi

**Abstract**

Presentation and discussion of current research topics in analytical chemistry

**Objective**

Presentation and discussion of current research topics in analytical chemistry

**Content**

Organic Chemistry

**Number**

529-1100-00L

**Title**

Fragrance Chemistry

**Type**

W

**ECTS**

1 credit

**Hours**

1V

**Lecturers**

P. Kraft

**Abstract**

The lecture provides a journey into the molecular world of scents from the chemical secrets behind Chanel N°5 to structure-odor relationships, industrial processes, and total synthesis of terpenoids. Each subunit is centered on one odorant family and highlights a certain class of chemical reactions, illustrated by prominent perfumery examples.

**Objective**

After completion of this lecture module the students know all the major perfumery materials of the important odor families with their academic and industrial syntheses, their olfactive properties, their usage, their historic perspective, and today's economic importance. The students can explain the significance of important building blocks and industrial transformations, and can estimate how attractive chemical processes are on large scale. They can retrosynthetically plan academic and industrial syntheses of fragrant compounds and terpenoids, and the acquired knowledge on structure-odor relationships enables them to predict and design new odorants. The students can approximate the conformational space of odorants and especially macrocycles on the basis of simple rules, and know how olfactophore models are used. The students understand and can explain the molecular mechanism of smell, the biosynthesis of terpenes, and the basics of perfumery composition. The latter enables them to further their education in perfume at specialized Universities such as the ISIPCA in Versailles; yet, the student also knows about the links of Fragrance Chemistry with Pharmaceutical Chemistry and the Specialty Chemicals business in general.

**Literature**


**Doctoral Studies in Physical Chemistry**

**Number**

529-0490-00L

**Title**

Special Topics in Theoretical Chemistry

**Type**

E-

**ECTS**

0 credits

**Hours**

1S

**Lecturers**

M. Reiher

**Abstract**

Weekly seminar programme on special topics in theoretical and quantum chemistry. Talks delivered by PhD students and PostDocs as well as by external speakers.

**Objective**

advanced course for PhD students and postdoctoral fellows

**Content**

current research topics in theoretical chemistry

**Lecture notes**

none

Data: 06.11.2018 12:57

Autumn Semester 2016

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructors</th>
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<tr>
<td>529-0460-00L</td>
<td>Computer Simulation</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>P. H. Hünenberger, S. Riniker</td>
</tr>
<tr>
<td>529-0427-00L</td>
<td>Electron Spectroscopy</td>
<td>W</td>
<td>1</td>
<td>2S</td>
<td>F. Merkt</td>
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<tr>
<td>Abstract</td>
<td>Group seminar on electronic spectroscopy, photoelectron spectroscopy, vacuum ultraviolet spectroscopy. Participation to this seminar must be discussed with the lecturer.</td>
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<tr>
<td>Prerequisites / notice</td>
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<tr>
<td>529-0479-00L</td>
<td>Theoretical Chemistry, Molecular Spectroscopy and Dynamics</td>
<td>W</td>
<td>1</td>
<td>2S</td>
<td>F. Merkt, M. Quack, M. Reiher, R. Riek, S. Riniker, H. J. Wörner</td>
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<tr>
<td>Abstract</td>
<td>Seminar on theoretical chemistry, molecular spectroscopy and dynamics.</td>
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<tr>
<td>529-0480-00L</td>
<td>Nuclear Magnetic Resonance Seminar</td>
<td>W</td>
<td>0</td>
<td>3S</td>
<td>B. H. Meier</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Research seminar on current problems in nuclear magnetic resonance spectroscopy</td>
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<tr>
<td>529-0489-00L</td>
<td>Introduction to the Construction of Measurement Devices in Physical Chemistry</td>
<td>W</td>
<td>2</td>
<td>2P</td>
<td>B. H. Meier</td>
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<tr>
<td>Abstract</td>
<td>Basic concepts of the construction of instrumentation in physical chemistry. Practical exercises in mechanical construction and electronic circuits.</td>
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<tr>
<td>Lecture notes</td>
<td>Unterlagen in der ersten Stunde verteilt.</td>
<td></td>
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<tr>
<td>Abstract</td>
<td>Institute-Seminar covering current research Topics in Physical Chemistry</td>
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<tr>
<td>529-0491-00L</td>
<td>Seminar in Computational Chemistry C4</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>H. P. Lüthi, P. H. Hünenberger, M. Reiher, S. Riniker</td>
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<tr>
<td>529-0495-00L</td>
<td>Seminar on Special Problems in Physical Chemistry</td>
<td>W</td>
<td>1</td>
<td>3S</td>
<td>M. Quack</td>
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<tr>
<td>Abstract</td>
<td>Research colloquium</td>
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<td>529-0481-00L</td>
<td>Advanced High Resolution Molecular Spectroscopy</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>S. Albert</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course teaches advanced topics in molecular spectroscopy; techniques for analysing rotationally and rovibrationally resolved spectra will be discussed, the basics of FTIR spectroscopy will be reviewed, and the sources which may be used in high resolution infrared spectroscopy will be described. The fields in which high resolution infrared /THz spectroscopy is applied will also be reviewed.</td>
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<tr>
<td>Objective</td>
<td>The students will understand how to use the tools needed to analyze simple highly resolved spectra. They will become familiar with experimental techniques in high resolution molecular spectroscopy and will understand how molecular spectroscopy can be applied to solve problems with respect to atmospheric pollutants and the detection of molecules in interstellar space.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>The students will learn how to record rotationally and rovibrationally resolved spectra in the THz and IR frequency range. For that purpose state-of-the-art sources like synchrotrons, FELs and other THz sources will be discussed. In this context, the basics of Fourier transform infrared spectroscopy will also be reviewed. The analysis of such spectra with interactive programs will then be explained. Finally, applications of high resolution molecular spectroscopy in the field of atmospheric and interstellar chemistry will be discussed. The identification and the quantitative determination of atmospheric pollutants will be discussed in detail. In addition, the identification of interstellar molecules in the context of the origin of life will be reviewed. The question of the identification of the interstellar unidentified infrared bands and of the interstellar diffuse bands will also be addressed. Finally, high resolution molecular spectroscopy of chiral molecules in the context of molecular parity violation will be discussed</td>
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<tr>
<td>Literature</td>
<td>Will be given in the lecture</td>
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<td>529-0470-00L</td>
<td>Literature Seminar in Theoretical Chemistry</td>
<td>Z</td>
<td>0</td>
<td>2S</td>
<td>M. Reiher</td>
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<tr>
<td>Abstract</td>
<td>In depth study of selected recent papers on theoretical chemistry</td>
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<tr>
<td>Objective</td>
<td>Doktorats- und Mitarbeiterschulung</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Content</td>
<td>Variert nach aktuellem Stand der Forschung</td>
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<tr>
<td>Literature</td>
<td>Will be announced on <a href="http://www.reiher.ethz.ch/courses-and-seminars.html">www.reiher.ethz.ch/courses-and-seminars.html</a></td>
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<td>529-0477-00L</td>
<td>Molecular Quantum Dynamics</td>
<td>Z</td>
<td>0</td>
<td>1V</td>
<td>R. Marquardt</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture covers advanced topics in ultra-fast time resolved molecular spectroscopy and kinetics. Although primarily theoretical, and focused on quantum phenomena, contents include the discussion of certain modern experimental techniques.</td>
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<tr>
<td>Objective</td>
<td>Goals are: acquisition of the basic knowledge in modern, ultra-fast Spectroscopy and chemical kinetics and of some knowledge of theoretical methods currently used to interpret experimental data; exercise the interpretation of computational results related to molecular quantum dynamics on selected examples and discussion of the problems involved.</td>
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</tr>
<tr>
<td>Content</td>
<td>The lecture is intended to be a brief introduction to essential aspects regarding quantum dynamics, in particular regarding molecular physics and the primary steps of chemical reactions. It proposes also an introduction to the methods and computational algorithms used in the theoretical treatment of molecular quantum dynamics, in particular of short time propagation of wave packets. A practical course in handling computer programs specifically devised for quantum dynamics is offered.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>A program and handouts can be downloaded from the indicated web site or will be delivered in the first session. Handouts are in English.</td>
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</table>
A solid knowledge in quantum mechanics is helpful, but not a condition to assist the lecture.

529-0485-00L  Calculating Free Energy Differences from Molecular Simulation: Theory and Practical Applications

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>529-0485-00L</td>
<td>Calculating Free Energy Differences from Molecular Simulation: Theory and Practical Applications</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>N. Hansen</td>
</tr>
</tbody>
</table>

Abstract: Theoretical analysis as well as issues of practical implementation of state of the art free energy methods.

Objective: Recognition of the concepts that underlie the different approaches devised for the determination of free energies

Content: A variety of fundamental chemical quantities such as binding or equilibrium constants, solubilities, partition coefficients, and adsorption coefficients are related to the difference in free energy between particular (non)physical states of a system. A maze of computational techniques to calculate free energies is nowadays available that differ in efficiency and accuracy. However, most of them are rooted in a few basic ideas. In the lecture state of the art methods are discussed in light of these basic ideas.

Lecture notes: Handouts will be provided


Doctoral Studies in Chemical and Bioengineering

Number | Title                                                                 | Type | ECTS | Hours | Lecturers |
|--------|----------------------------------------------------------------------|------|------|-------|-----------|

Abstract: This course comprises a series of seminars on current topics regarding environmental impact and safety of chemical products and processes. Invited national and international speakers from public and industrial research institutions present their latest developments and applications, and show future trends.

Objective: Giving the students the opportunity to experience recent research progress at first hand; encouraging participation in discussions with speaker and audience.

529-0072-00L  Chemical Process Technology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0072-00L</td>
<td>Chemical Process Technology</td>
<td>W</td>
<td>1</td>
<td>2S</td>
<td>M. Morbidelli</td>
</tr>
</tbody>
</table>

Abstract: The course is constituted of a series of seminars on various topics of relevance in chemical engineering, with specific emphasis on those of direct interest in the research area of the group. Speakers are invited from various national and international institutions.

Objective: Expose the students to the most recent advances in the general area of chemical engineering.

Content: The course is constituted of a series of seminars on various topics of relevance in chemical engineering, with specific emphasis on those of direct interest in the research area of the group. Speakers are invited from various national and international institutions.

Lecture notes: When available, will be distributed at the end of the single seminar.

529-0690-00L  ICB Seminars on Chemical and Biochemical Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>529-0690-00L</td>
<td>ICB Seminars on Chemical and Biochemical Engineering</td>
<td>W</td>
<td>1</td>
<td>2S</td>
<td>A. de Mello</td>
</tr>
</tbody>
</table>

Abstract: The ICB seminar series covers the umbrella of diverse research activities encompassed within the institute, including catalysis, functional materials, polymer engineering, separations, microfluidics, process design, and systems engineering. This series was founded with the aim of promoting cross-disciplinary scientific discourse and interaction with other distinguished groups working worldwide.

Objective: Students are expected to attend all seminars in one academic year, and should register at the beginning of each seminar. Additionally they must deliver a two page written report at the end of the year describing the topics covered, main conclusions, and interrelationships between the different themes.

Content: The ICB seminar series covers the umbrella of diverse research activities encompassed within the institute, including catalysis, functional materials, polymer engineering, separations, microfluidics, process design, and systems engineering. This series was founded with the aim of promoting cross-disciplinary scientific discourse and interaction with other distinguished groups working worldwide, and is targeted at individuals who have made outstanding contributions within their fields. Each year, around 7 distinguished scientists and technologists will be invited to speak on topics of current interest in Chemical and Biochemical Engineering. PhD students are particularly encouraged to attend in order to broaden their perception and enrich their scientific horizons.

Lecture notes: When available, will be distributed at the end of the single seminar.

Doctoral Studies in Polymer Science

Number | Title                                                                 | Type | ECTS | Hours | Lecturers |
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>529-0585-00L</td>
<td>Reactivity in Micelles and Vesicles</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>P. J. Walde</td>
</tr>
</tbody>
</table>

Abstract: Discussion of different aspects of the chemical reactivity in micelles and in vesicles (liposomes) as polymolecular compartments.

Objective: Deeper understanding of micelles and vesicles as self-organizing reaction compartments.

Content: With a few selected recent examples, properties of micelles and vesicles will be discussed with respect to applications as reaction compartments.

Lecture notes: No script

Doctoral Studies in Pharmaceutical Sciences

Number | Title                                                                 | Type | ECTS | Hours | Lecturers |
<table>
<thead>
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<tbody>
<tr>
<td>535-2000-00L</td>
<td>Seminar für Mitarbeiter</td>
<td>W</td>
<td>0</td>
<td>2S</td>
<td>G. Schneider</td>
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</table>

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 420 of 1571
Abstract
Weekly group seminar, in which members of the research team present and discuss the results of their projects and selected reports from the current scientific literature.

Objective
Participants learn to present scientific studies and discuss own results in greater context.

535-0900-00L Seminars on Drug Discovery and Development

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract
State-of-the-art information on drug discovery and development by experts from academia and industry.

Objective
State-of-the-art information on drug discovery and development.

Content
Seminar series of the Institute of Pharmaceutical Sciences. Experts from academia and industry report on relevant topics.

Lectures and Optional subjects in MSc Pharmaceutical Sciences

Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0195-00L</td>
<td>Scientific Information Retrieval &amp; Management in Life Sciences and Chemistry</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>O. Renn</td>
</tr>
</tbody>
</table>

Abstract
Students will learn how to effectively retrieve, critically judge, analyze and manage published scientific information - important skill sets in chemistry and life sciences where scientists need to deal with vast amounts of information. The course, being based on practical examples, also covers scientific writing & communication and state-of-the-art technologies for analysis such as text mining.

Objective
Ability to select appropriate, subject-specific databases or tools for a given specific scientific question based on a sound understanding on how a tool or database has been developed and maintained, thus building the personal capacity of doing research effectively and efficiently by integrating scientific information into the research process when needed. Ability to communicate own scientific results using additional distribution channels. Ability to easily write-up the Ph.D. thesis or first paper.

Content
The course has been primarily designed for Ph.D. students, also for the Life Science Zurich Graduate School, but is also open to Master students. In a series of 13 lectures, which always include practical examples (for some lectures an own notebook is required), the use of scientific information is taught not in a database-centric view but corresponding to the steps through which scientific research is conducted - including the dissemination of scientific results. This is particularly interesting for students who are about to write-up their first paper or thesis.

Students will learn about the different types of information resources and tools, get an insight into the numerous databases and tools that exist and how those are built and maintained, enabling them to critically judge the value and trustworthy of a information resource. Additionally, they will learn how to communicate their own scientific results properly, using also additional measures that are reflected by alternative metrics.

The following topics are covered:
1. The World of Scientific Publishing
2. Searching and Retrieving Scientific Information Using Search Engines and Using Literature Databases
3. Searching and Retrieving Scientific Information Using Subject-specific Databases in Chemistry
4. Searching and Retrieving Scientific Information Using Subject-Specific Databases in Life Sciences
5. Tools for Managing the Retrieved Scientific Information
7. Patents
8. Text(Literature) and Data Mining
9. Communicating & Analyzing the Impact of (Your) Science
10. Scientific Writing & Good Scientific Practice

Lecture notes
The slide deck and supplementary materials will be made available in the teaching document repository (ILIAS) after each lecture.

Literature
Additional literature and reference are provided in the course material.

Course Catalogue of ETH Zurich

Doctoral Department of Chemistry and Applied Biosciences - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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Key for Hours

<table>
<thead>
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<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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ECTS
European Credit Transfer and Accumulation System

Key special students and auditors need special permission from the lecturers.
# Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>651-0254-00L</td>
<td>Seminar Geochemistry and Petrology</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>O. Bachmann, M. Schönächler, C. A. Heinrich, M. W. Schmidt, D. Vance</td>
</tr>
</tbody>
</table>

### Abstract
Seminar series with external and occasional internal speakers addressing current research topics. Changing programs announced via D-ERDW homepage (Veranstaltungskalender)

### Objective
Presentations on isotope geochemistry, cosmochemistry, fluid processes, economic geology, petrology, mineralogy and experimental studies. Mostly international speakers provide students, department members and interested guests with insight into current research topics in these fields.

### Content
Wochehentliches Seminar mit Fachvorträgen eingeladener oder interner Wissenschaftler, vornehmlich zu Themen der Geochemie, Isotopengeochemie, Hydrothermalgeochemie, Lagerstättenbildung, Petrologie, Mineralogie und experimentelle Studien.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>651-1617-00L</td>
<td>Geophysical Fluid Dynamics and Numerical Modelling Seminar</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>P. Tackley, M. D. Ballmer, T. Gerya, D. A. May</td>
</tr>
<tr>
<td>651-0251-00L</td>
<td>Seminar Petrology</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>M. W. Schmidt, O. Bachmann</td>
</tr>
</tbody>
</table>

### Abstract
Seminar series with external and occasional internal speakers addressing current research topics in Petrology.

### Objective

### Content
Seminar series addressing current research topics in Petrology (Magmatic Petrology and Crystalline Geology and Experimental Petrology).

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>651-4931-00L</td>
<td>Heat and Mass Transfers in Magmatology</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>O. Bachmann, J. Leuthold</td>
</tr>
</tbody>
</table>

### Abstract
Heat and mass transfers in the crust control many aspects of the differentiation of our planet, including (1) type of volcanic eruptions we should expect at the surface of our planet, (2) the volcanic/plutonic ratio in the crust, and (3) how volcanic degassing occurs, with important consequences on the climate response following volcanic eruptions.

### Objective
The goal of this class is to learn about the modern methods and ideas on heat and mass transfers in magmatology through recently published papers and computer softwares. The class will allow students to explore some of the most challenging concepts in this field, and become familiar with state-of-the-art techniques to model these processes.

### Content
The class will focus mostly on reading recent literature on topics of interests, and will contain some computer exercises to allow students to work by themselves on some well-defined problems.

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<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>651-4123-00L</td>
<td>Earthquake Physics and Numerical Modelling Paper</td>
<td>W</td>
<td>1</td>
<td>1S</td>
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### Prerequisites / notice
This course will not be given Fall 2016. Instead I refer to a potential option Spring 2016 or Earthquake Source Physics given Fall 2017.

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Data: 06.11.2018 12:57 Autumn Semester 2016 Page 422 of 1571
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>851-0125-03L</td>
<td>Research Colloquium for Ph.D.-Students and Members of Staff</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>L. Wingert</td>
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<td></td>
<td>Ph.D. students and members of staff report on their research. Participants will learn to know arguments and ideas dealing with systematic problems in philosophy.</td>
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<tr>
<td>851-0551-00L</td>
<td>Colloquium for Master and Ph.D. Students</td>
<td>W</td>
<td>2 credits</td>
<td>1K</td>
<td>G. Hürlimann</td>
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<td></td>
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<td></td>
<td>Colloquium for master and doctoral students preparing a thesis in the history of technology. Goals: to identify, discuss, and resolve methodological problems that emerge while elaborating a master or doctoral thesis.</td>
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<tr>
<td>851-0587-00L</td>
<td>CIS Colloquium</td>
<td>E-</td>
<td>2 credits</td>
<td>2K</td>
<td>L.E. Cederman, M. Steenbergen</td>
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<td></td>
<td>Abstract</td>
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<td></td>
<td>This seminar is open for staff members based at the Center for Comparative and International Studies, CIS.</td>
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<tr>
<td>862-0088-00L</td>
<td>Research Colloquium Science Studies</td>
<td>E-</td>
<td>2 credits</td>
<td>1K</td>
<td>M. Hagner</td>
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<td>Abstract</td>
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<td>This colloquium is devoted to the introduction into the theory and practice of scientific work. The schedule can be found on the institute's website - <a href="http://www.wiss.ethz.ch/en/teaching/">http://www.wiss.ethz.ch/en/teaching/</a></td>
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<tr>
<td>851-0587-01L</td>
<td>CIS Doctoral Colloquium</td>
<td>W</td>
<td>2 credits</td>
<td>1K</td>
<td>P. Holtrup Mostert</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>In this internal colloquium doctoral students present their work after about 12 months of research. The aim of this colloquium is that the presenters receive feedback on their research at an important stage (a stage at which significant changes of direction, methodology, etc, may still be undertaken) in the PhD process.</td>
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<tr>
<td>851-0549-00L</td>
<td>WebClass Introductory Course History of Technology</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>G. Hürlimann</td>
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<td>Objective</td>
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<td></td>
<td>Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.</td>
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<tr>
<td>851-0626-02L</td>
<td>PhD Colloquium in Development Economics</td>
<td>W</td>
<td>2 credits</td>
<td>1K</td>
<td>I. Günther</td>
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<tr>
<td></td>
<td>Objective</td>
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<td>PhD students interested in empirical development economics will present their ongoing work, with a particular focus on the methods (to be) used and challenges faced. Participants are expected to read the drafts/papers/presentations beforehand and give constructive feedback to the PhD student presenting.</td>
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<tr>
<td>851-0735-10L</td>
<td>Business Law</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>P. Peyrot</td>
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<td></td>
<td>Objective</td>
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<td>The colloquium will take place 8 times per semester. The schedule will be arranged together with the PhD students at the beginning of the semester.</td>
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</table>
The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.

**Objective**
- They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise.
- They shall be acquainted with corporate functions as contracting, negotiation, clarification, proprietariness and dispute resolution.
- They shall be familiar with the issues of corporate compliance, i.e. the system to ascertain that all legal and ethical rules are observed.
- They shall be able to contribute to the legal management of the company and to discuss legal issues.
- They shall have an understanding of the law as a part of the corporate strategy and as a valuable resource of the company.

**Lecture notes**
A comprehensive script will be made available online on the moodle platform.

**851-0735-09L Workshop & Lecture Series on the Law & Economics**

**Abstract**
This series is a joint project by ETH Zurich and the University of Zurich. It provides an overview of interdisciplinary research on intellectual property, innovation, antitrust and technology policy. Scholars from law, economics, management and related fields give a lecture and/or present their current research. All speakers are internationally well-known experts from Europe, the U.S. and beyond.

**Objective**
After the workshop and lecture series, participants should be acquainted with interdisciplinary approaches towards intellectual property, innovation, antitrust and technology policy research. They should also have an overview of current topics of international research in these areas.

**Content**
The workshop and lecture series will present a mix of speakers who represent the wide range of current social science research methods applied to intellectual property, innovation, antitrust policy and technology policy issues. In particular, theoretical models, empirical and experimental research as well as legal research methods will be represented.

**Lecture notes**
Papers discussed in the workshop and lecture series are posted in advance on the course web page.

**Literature**
- Suzanne Scotchmer, Innovation and Incentives, 2004
- Bronwyn Hall / Nathan Rosenberg (eds.), Handbook of the Economics of Innovation, 2010
- Bronwyn Hall / Dietmar Harhoff, Recent Research on the Economics of Patents, 2011
- Paul Belleflamme / Martin Peitz, Industrial Organization: Markets and Strategies, Cambridge 2010
- Einer Elhauge / Damien Geradin, Global Competition Law and Economics, 2007
- Dennis Carlton / Jeffrey Perloff, Modern Industrial Organization, 4th edition, 2004

**851-0125-18L Self-Ownership - Philosophical and Juridical Perspectives**

**Abstract**
Rights in Objects are founded by an inalienable Self-Ownership. These Idea ist central for personal rights. We speak of my body, my genes, my name, my portrait, my ideas oder ways of expression.

**Objective**
Participants will make acquaintance with founding texts of the natural rights property concept (John Locke). They will see the connection between inalienable self-ownership, prohibition of slavery, derivative commercial rights and modern personal rights. They will learn about the problems of self-ownership today concerning property in one's body and intellectual property. Critical alternatives to the property paradigm will be discussed.

**Content**
Participans will have the opportunity to gain access to unfamiliar texts from the philosophical tradition and to see their relevance today. They experience the consequences of a certain use of concepts and orient themselves in current bioethical, juridical and political discussions.

**Literature**
- Texts by Locke, Nozick, Christian, Otsuka, Rasmussen, Schneider, Stirner, Fichte and  Forschner. Founding of property right in self-ownership (Locke), revival of this concept in Nozick and his egalitarian critics. Critique of the concept of self-ownership related to property in one's body. Looking back to the personal self-relatedness that comes up again in Intellectual Property and in modern personal rights.

**851-0585-15L Complexity and Global Systems Science**

**Prerequisites: solid mathematical skills Particularly suitable for students of D-ITET, D-MAVT**

**Abstract**
This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.

**Objective**
Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

**Content**
This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at “tipping points”, multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or “tragedies of the commons” such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating techno-socio-economic-environmental problems, and what data science may contribute to their solution.

**851-0240-15L Colloquium on the Science of Learning and Instruction**

**Abstract**
In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EduETH (ETH) and in the Institute for Educational Sciences (LZHE).

**Objective**
Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.

**851-0738-00L Intellectual Property: Introduction**

**W** 2 credits 2V  M. Schweizer
The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights). Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.

The aim of this course is to enable students at ETH Zurich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.

Another goal is to enable the students to participate in the current debate over the goals and desirability of protecting intellectual creations, particularly in the areas of copyright (keywords: fair use, Creative Commons, Copyleft) and patent law (software patents, patent trolls, patent thickets).

### 851-0738-01L
**The Role of Intellectual Property in Daily Routine: A Practical Introduction**
**Abstract**
The lecture gives an overview of the fundamental aspects of intellectual property, which plays an important role in the daily routine of engineers. The lecture aims to make participants aware of the various methods of protection and to put them in a position to use this knowledge in the workplace.

**Objective**
In recent years, knowledge about intellectual property has become increasingly important for engineers. Both in production and distribution and in research and development, engineers are increasingly being confronted with questions concerning the patenting of technical inventions and the use of patent information.

The lecture will acquaint students with practical aspects of intellectual property and enable them to use the acquired knowledge in their future professional life.

**Topics covered during the lecture will include:**
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups.

**Case studies will illustrate and deepen the topics addressed during the lecture.**

**Prerequisites / notice**
The seminar will comprise practical exercises on how to use and search patent information. Basic knowledge of how to read and evaluate patent documents as well as how to use publicly available patent databases to obtain the required patent information will also be provided.

The lecture is in particular tailored to the needs of the following degree programs: Agricultural science, architecture, civil engineering, computational science and engineering, computer science, electrical engineering and information technology, environmental engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-related degree programs, the lecture ‘Protecting inventions in chemistry’ (851-0738-03) will be offered in the autumn semester.

### 851-0157-00L
**Mind and Brain**
**Abstract**
In the last 2500 years, the mind-brain relationship has been articulated in various ways. In these lectures, I will explore the scientific and philosophical aspects of this relationship in the context of relevant cultural, historical and technological processes, with a focus on the modern neuosciences, but I will also discuss works of art and literature.

**Objective**
By the end of this lecture, students should be familiar with essential positions in the scientific and philosophical treatment of questions relating the mind to the brain. It should also become clear that some of the most relevant problems in current neurosciences have a long history.

**Content**
According to a myth, the ancient Greek philosopher Democrit dissected animals, because he was in search of the seat of the soul. Current neuoscietists use neuroimaging techniques like functional magnetic-resonance-tomography in order to localize cognitive and emotional qualities in the brain. Between these two dates lies a history of 2500 years, in which the relationship between the mind and the brain has been defined in various ways. Starting with ancient and medieval theories, the lecture will have its focus on modern theories from the nineteenth century onward. I will discuss essential issues in the history of the neurosciences such as localization theories, the neuron doctrine, reflex theory, theories of emotions, neurocyrnetics and the importance of visualizing the brain and its parts, but I will also include works of art and literature.

### 851-0125-41L
**Introduction Into Philosophy of Technology**
**Abstract**
Since antiquity philosophy reflects about and evaluates technology. The technical developments in the 19th and 20th century have led to a autonomous philosophy of technology, which had become important also for other philosophical disciplines (e.g. in Heidegger's philosophy).

**Objective**
The course gives an overview on the main schools in the philosophy of technology. Students should learn to analyse and evaluate different philosophies of technology (compensation, objectification, externalisation). For credit point a critical protokoll is to be written.

### 851-0252-04L
**Behavioral Studies Colloquium**
**Abstract**
This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their research ideas in relation to behavioral science. The colloquium also features invited research talks.

**Objective**
Students know and can apply autonomously up-to-date investigation methods and techniques in the behavioral sciences. They achieve the ability to develop their own ideas in the field and to communicate their ideas in oral presentations and in written papers. The credits will be obtained by a written report of approximately 10 pages.
This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their ideas in so far as they have some relation to behavioral science. The possible research areas are wide and may include theoretical as well as empirical approaches in Social Psychology and Research on Higher Education, Sociology, Modeling and Simulation in Sociology, Decision Theory and Behavioral Game Theory, Economics, Research on Learning and Instruction, Cognitive Psychology and Cognitive Science. Ideally the students (from Bachelor, Master, Ph.D. and Post-Doc programs) have started to start work on their thesis or on any other term paper.

Course credit can be obtained either based on a talk in the colloquium plus a written essay, or by writing an essay about a topic related to one of the other talks in the course. Students interested in giving a talk should contact course organizers (Rütsche, Stern) before the first session of the semester. Priority will be given to advanced / doctoral students for oral presentations. The course credits will be obtained by a written report of approximately 10 pages. The colloquium also serves as a venue for invited talks by researchers from other universities and institutions related to behavioral and social sciences.

851-0252-01L Human-Computer Interaction: Cognition and Usability
Number of participants limited to 30.

Abstract
This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects.

Objective
This seminar will introduce key topics, theories and methodology in human-computer interaction (HCI) and usability. Presentations will cover basic concepts of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that first familiarize themselves with a select usability evaluation method (e.g. user testing, GOMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the plenary. Active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay / report will be required (details to be specified in the introductory session of the course).

851-0252-02L Introduction to Cognitive Science
Number of participants limited to 70.

Abstract
The lectures provide an overview of the foundations of cognitive science and investigate processes of human cognition, especially perception, learning, memory and decision-making. This includes a comparison of cognitive and technical systems, especially with respect to knowledge acquisition, knowledge representation and usage in information processing tasks.

Objective
Cognitive Science views human cognition as information processing and provides an inter-disciplinary integration of approaches from cognitive psychology, informatics (e.g., artificial intelligence), neuroscience and anthropology among others. The lectures provide an overview of basic mechanisms of human information processing and various application domains. A focus will be on matters of knowledge acquisition, representation and usage in humans and machines. Models of human perception, reasoning, memory and learning are presented and students will learn about experimental methods of investigating and understanding human cognitive and representation structures.

851-0252-03L Cognition in Architecture - Designing Orientation and Navigation for Building Users
Number of participants limited to 40.

Abstract
How can behavioral and cognitive science inform architecture? This project-oriented seminar investigates contributions of cognitive science to architectural design with an emphasis on orientation and navigation in complex buildings and urban settings. It includes theories on spatial memory and decision-making as well as hands-on observations of behavior in real and virtual reality.

Objective
Taking the perspectives of building users (occupants and visitors) is vital for a human-centered design approach. Students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to understand human behavior in built environments. The foundations of environmental psychology and human spatial cognition will be introduced. A focus of the seminar will be on how people perceive their surroundings, how they orient in a building, how they memorize the environment and how they find their way from A to B. Students will also learn about a range of methods including real-world observation, virtual reality experiments, eye-tracking, and behavior simulation for design. Students will reflect on the roles of designers and other stakeholders with respect to human-centered design and an evidence-based design perspective. The seminar is geared towards a mix of students from architecture / planning, engineering, computer science and behavioral science as well as anybody interested in the relation between design and cognition.

851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB
Number of participants limited to 70.

Abstract
This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Lecture notes
The lecture slides will be presented on the course web page after each lecture.

Literature

Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

Prerequisites / notice
The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

862-0089-00L Advanced Colloquium in Literary Studies
Colloquium is designed for advanced and graduated students.

Number of participants limited to 10.

Abstract
This colloquium is designed for advanced and graduated students. It is particularly suitable for students of D-ARCH, D-INFK, D-ITET.

Objective
This colloquium is designed for advanced and graduated students. It is particularly suitable for students of D-ARCH, D-INFK, D-ITET.

Content
This colloquium is designed for advanced and graduated students. It is particularly suitable for students of D-ARCH, D-INFK, D-ITET.

Literature
This colloquium is designed for advanced and graduated students. It is particularly suitable for students of D-ARCH, D-INFK, D-ITET.
Abstract

The colloquium addresses advanced and graduate students. First, it offers participants the opportunity to present their own research projects (work in progress); and, second, it provides a most fruitful space to discuss methodological, theoretical and systematic complex issues.

Objective

The colloquium addresses advanced and graduate students. First, it offers participants the opportunity to present their own research projects (work in progress); and, second, it provides a most fruitful space to discuss methodological, theoretical and systematic complex issues.

851-0252-05L

Research Colloquium Cognitive Science

| W | 1 credit | 2K | C. Hölscher, V. Schinazi, T. Thrash |

Prerequisite: Participants should be involved in research in the cognitive science group.

Abstract

The colloquium provides a forum for researchers and graduate students in cognitive science to present/discuss their ongoing projects as well as jointly discuss current publications in cognitive science and related fields. A subset of the sessions will include invited external visitors presenting their research. Participants of this colloquium are expected to be involved in active research group.

Objective

Graduate student train and improve their presentation skills based on their own project ideas, all participants stay informed on current trends in the field and have the opportunity for networking with invited scholars.

851-0738-03L

Protecting Inventions in Chemistry

| W | 2 credits | 2V | C. Softmann |

Particularly suitable for students of D-CHAB

Abstract

The lecture gives students of chemistry-related degree programs an overview of the options to protect inventions and the underlying research efforts. The lecture aims to put the participants in a position to use this know-how in the workplace.

Objective

Investments and development play an important role in chemistry-related technology sectors such as inorganic and organic chemistry or pharmacy.

The seminar is customised to the needs of chemists and students of related degree programs. Participants will become familiar with practice-oriented aspects of intellectual property and will be enabled to use the acquired knowledge in their future professional life.

Topics covered during the lecture will include:

- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups
- Special aspects of protecting inventions in chemistry-related sectors, e.g. polymorphs and inventions in the field of nanotechnology.

Case studies will illustrate and deepen the topics addressed during the lecture.

The seminar will comprise practical exercises on how to use and search patent information. Basic knowledge of how to read and evaluate patent documents as well as how to use publicly available patent databases to obtain the required patent information will also be provided.

The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, biotechnology, chemical engineering, chemistry, food science, pharmaceutical sciences.

For engineering and physics students, the lecture 'The Role of Intellectual Property in daily routine: A Practical Introduction' (851-0738-01) will be offered in the autumn semester.

851-0558-41L

Computational Social Science

| W | 3 credits | 2S | D. Helbing, M. Leiss, O. C. Rouly |

Abstract

The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and phenomena together with related empirical, experimental, and data-driven work, (2) combining perspectives of different scientific disciplines (e.g. sociology, computer science, physics, complexity science, engineering), (3) bridging between fundamental and applied work.

Objective

Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

They should also be able to explain how systemic instabilities can be understood by changing the perspective from a component-oriented to an interaction- and network-oriented view, and what fundamental implications this has for the proper design and management of complex dynamical systems.

Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

851-0252-07L

Recent Debates in Social Networks Research

| W | 2 credits | 2S | C. Stadtfeld, P. Block |

Number of participants limited to 30

Abstract

Social Networks research is a highly interdisciplinary fields. For example, scholars in Sociology, Psychology, Political Sciences, Computer Science, Physics, Mathematics and Statistics contribute to the development of theories and methods. This course aims at understanding, comparing and structuring recent debates in the field of Social Networks.

Objective

Social Networks research is a highly interdisciplinary fields. At the end of this seminar, students will understand and be able to compare different subject-specific approaches to social networks research (e.g., from Sociology, Psychology, Political Sciences, Computer Science, Physics, Mathematics and Statistics). They will be familiar with recent publications in the field of Social Networks and be able to critically participate in a number of recent debates. Amongst others, these debates touch upon the co-evolution of selection and influence mechanisms, appropriateness of statistical models, generic mechanisms and features of social networks, models for the analysis of dynamic networks.

364-1062-00L

Experimental Methods

| W | 1 credit | 1V | C. Waibel |

This course is complemented by a course on z-Tree

Data: 06.11.2018 12:57
Autumn Semester 2016 Page 427 of 1571
Understanding of the various forms and functions of repetition on the basis of texts by Plato (anamnesis), Freud (repetition compulsion), and W.K. Stocker

To gain an overview of the history of the transition of large technical systems

Introduction: What are economic experiments and why to use them?

The course introduces PhD students into the principles of experimental methods and outlines how to prepare, conduct and evaluate an experiment.

1. Introduction: What are economic experiments and why to use them?


4. Conducting experiments: Instructions, testing, recruiting, sessions.

5. Measuring techniques: Eliciting beliefs, risk attitudes, social preferences.


Literature

Books:

Basic Articles:

A reading list with articles for each lecture has been published in Moodle.

Prerequisites / notice

This course is complemented by a course on programming experiments with z-tree. It is not mandatory but recommended to take both courses.

Abstract

This course introduces PhD students into the principles of experimental methods and outlines how to prepare, conduct and evaluate an experiment.

Objective

This course aims to prepare PhD students for conducting their own experiment.

Content

1. Introduction: What are economic experiments and why to use them?


4. Conducting experiments: Instructions, testing, recruiting, sessions.

5. Measuring techniques: Eliciting beliefs, risk attitudes, social preferences.


Literature

Books:

Basic Articles:

A reading list with articles for each lecture has been published in Moodle.

Prerequisites / notice

This course is complemented by a course on programming experiments with z-tree. It is not mandatory but recommended to take both courses.

851-0125-00L Introduction to Epistemology

W 3 credits 2G N. El Kassar

Abstract

In this course we will examine fundamental questions of epistemology, e.g. What is knowledge? How are we to conceive of perception? Which beliefs are rational and justified? How do we acquire knowledge? By discussing a selection of seminal philosophical texts we will study fundamental epistemological theories.

Objective

- conceptions of fundamental epistemological concepts
- sensitivity to epistemological questions
- capacity to reflect epistemological theories
- capacity to discuss epistemological theories
- reading philosophical texts (including English texts)

851-0609-06L Governing the Energy Transition

3 credits 2V T. Schmidt

Number of participants limited to 30.

Abstract

This course addresses the role of policy and its underlying politics in the transformation of the energy sector. It covers historical, socio-economic, and political perspectives and applies various theoretical concepts to specific aspects of governing the energy transition.

Objective

- To gain an overview of the history of the transition of large technical systems
- To recognize current challenges in the energy system to understand the theoretical frameworks and concepts for studying transitions
- To demonstrate knowledge on the role of policy and politics in energy transitions
- To give a presentation (15-20 minutes) on one of the weekly topics during that particular session. The presentation (30%) and participation in the discussions (20%) will form one part of the final grade, the remaining 50% of the final grade will be formed by a final exam.

Content

Climate change, access to energy and other societal challenges are directly linked to the way we use and create energy. Both the recent United Nations Paris climate change agreement and the UN Sustainable Development Goals make a fast and extensive transition of the energy system necessary.

This course introduces the social and environmental challenges involved in the energy sector and discusses the implications of these challenges for the rate and direction of technical change in the energy sector. It compares the current situation with historical socio-technical transitions and derives the consequences for policy-making. It then introduces theoretical frameworks and concepts for studying innovation and transitions. It then focuses on the role of policy and policy change in governing the energy transition, considering the role of political actors, institutions and policy feedback.

The course has a highly interactive (seminar-like) character. Students are expected to actively engage in the weekly discussions and to give a presentation (15-20 minutes) on one of the weekly topics during that particular session. The presentation (30%) and participation in the discussions (20%) will form one part of the final grade, the remaining 50% of the final grade will be formed by a final exam.

Lecture notes

A reading list will be provided via moodle.ethz.ch (only for registered students).

Prerequisites / notice

This course is particularly suited for students of the following programmes: MA Comparative International Studies; MSc Energy Science & Technology; MSc Environmental Sciences; MSc Management, Technology & Economics; MSc Science, Technology & Policy; ETH & UZH PhD programmes.

851-0253-03L The Sense of Time and its Effects on Motivation, Cognition, and Emotion

2 credits 2S K. Stocker

Number of participants limited to 45.

Abstract

While time is studied prominently in physics, it is also an integral part of our mind. Some of the main parameters of our sense of time are time immersion, time specificity, time speed, time texture, time horizon, time motion, time embodiment, and lifetime localization. Our sense of time can (often unconsciously) have profound effects on our motivation, cognition, and emotion.

Objective

To learn and understand how our sense of time influences our motivation, cognition, and emotion and to learn that our sense of time is combination with difference as a positive mode of thinking change.

851-0148-04L Cyclical time

3 credits 2S T. Böhm

Abstract

The idea of cyclical time is found in ancient pieces of wisdom (Pythagoreans, Plato, Buddhism) as reincarnation or memory, but also in Nietzsche as eternal return, in Deleuze as repetition, in Freud as repetition compulsion. We investigate the concept of repetition in combination with difference as a positive mode of thinking change.

Objective

Understanding of the various forms and functions of repetition on the basis of texts by Plato (anamnesis), Freud (repulsion compulsion), Kierkegaard (narration), Nietzsche (eternal return as cosmological and ethical principle), Deleuze (time synthesis and repetition of the future), Poincaré's theorem of recurrence.

851-0301-04L Photography and Literature. Exchanging Practices

3 credits 2G F. Broggi-Wüthrich

Abstract

The course discusses writers from Henry James to Margaret Atwood whose interest for photography led them to elaborate new intriguing modes of representation. The aim is to identify how literature, photography and art meet to promote a photographic aesthetics while approaching the theories of Susan Sontag, Roland Barthes and Bourdieu as well as postmodern or posthuman criticism.

Objective

Students know a wide variety of literary text (and their authors) that are related in content or form to the practice of photography. Students know how to relate texts to key critical theories as well as to the historical and social context.
Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.

**3 credits**

**Postal Knowledge and the History of Digital Societies**

This course provides an introduction to philosophical issues surrounding quantum physics. In particular, we will examine different interpretations of quantum mechanics (such as the many-world interpretation) and the transition between the quantum and the classical physical realm (here phenomena such as decoherence will be highlighted).

**Objective**

By the end of the course students are able to describe and compare different interpretations of quantum mechanics. They are able to identify and examine issues concerning these different interpretations and issues concerning the transition between quantum and classical descriptions in physics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific contexts.

**851-0144-19L**

**Philosophy of Time**

**Objective**

By the end of the course students are able to describe and compare different theories and concepts of time (physical time, perceptual time, historical time, ...). They are able to identify and examine issues concerning time as they occur in various philosophical subdisciplines - especially in philosophy of science, philosophy of mind, metaphysics, and ethics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific and social contexts.

Part of the course reflects on methods and contents from physics, neuroscience/cognitive science, and logic.

**Beginnings**

"All beginnings are difficult," goes the saying, "but without them there wouldn't be an end." However, what makes beginnings so difficult? What kind of action is that? Which knowledge does it presuppose? And what would a beginning say about the end? We will pursue these questions by reading sacred, philosophical, literary, and scientific texts that, each in its own way, make a beginning.

**Prerequisites / notice**

All interested students are most welcome. The course is not intended as a language course but a good knowledge of English is a necessary requirement in order to participate to class discussions and to do the reading.

**851-0301-05L**

**Literature and Technology - Simulations, Prototypes, Machines**

**Abstract**

Literature about technology transposes models, products and procedures of scientific progress into the logic of poetry. This literature converts not only technology into fiction, but it also creates new cultural and social contextualisations, which reveal alternative readings of configurations of knowledge.

**Objective**

- thorough reading and critical analysis of the texts
- reflection upon the conditions and practice of beginnings in terms of their epistemology and rhetorical strategy (i.e. as an intellectual and literary operation)
- consider the cultural and historical function of fictions that tell of origins, such as cosmological myths, foundationalist philosophy, or poetic incantations

**Literature**

Myths of Creation and First Origins (Genesis and Gospel of St. John, Theogony, Upanishads), philosophy (Fichte, Hegel), literature and poetry (Wieland, Hölderlin, Novalis, Wordsworth, Melville, Richard Wagner, Beckett). For an introduction, see Wolfgang Iser, Emergenz: Nachgelassene und verstreut publizite Essays (Konstanz 2013).

**851-0306-05L**

**Literature and Technology - Simulations, Prototypes, Machines**

**Objective**

Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.


**851-0551-03L**

**Postal Knowledge and the History of Digital Societies**

**Abstract**

In the second half of the 20th century, postal services have dramatically changed. Communication today is computerbased. The lecture offers problem oriented insights into this sociotechnical process of translation.

**Objective**

Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication.

**Content**


**851-0157-66L**

**Who was Sigmund Freud?**

This seminar is devoted to the introduction into the ideas and concepts of one of the most influential thinkers of the 20th century. We will read selected texts by Freud for getting an overview over his medical, psychological and cultural thinking.

**Objective**

30 years ago it would have been bizarre to ask the question: Who was Sigmund Freud? The influence of psychoanalysis on twentieth century thinking was taken for granted even by those ones who rejected Freud's ideas. In contrast, the question today would be: What are Freud's central theories? We will tackle this question in the seminar and reconstruct Freud's thinking from his early medical writings to those writings, in which he developed a critical view of his time. The aim of the seminar is not only to understand Freud's thinking in historical context, but also to reflect, what it could mean to us in early twentyfirst century.

**851-0125-57L**

**Values in Science**

**Abstract**

Should science be free from moral, political or ideological influences? According to the so-called value-free ideal it should. Many scientists think of themselves as committed to truth and objectivity and nothing else. In this seminar, we will track the history of the value-free ideal and engage in a debate about the potential role of so-called non-epistemic values in science.

**Objective**

In the past decades, philosophers of science have begun to challenge the value-free ideal in science. With the help of recent literature from the philosophy of science, students will be introduced to the debate on values in science and the reasons for why the value-free ideal has come under attack. They will be familiarized with the distinction between epistemic (truth-conducive) values and so-called non-epistemic values. The course aims at enabling students to critically reflect the potential role of non-epistemic values in science.

**Content**

wwwblogs.ethzchvaluesinscience/

**Literature**

wwwblogs.ethzchvaluesinscience/

**851-0101-18L**

"Bollywood and Beyond" - A Cultural History of Indian
Abstract of Cinema in the 20th Century
The Indian film industry has been around for 100 years and is one of the richest and most variegated of the world. The lecture reconstructs the historical development of Indian cinema and uses it as a lens through which cultural, social and political change in the subcontinent can be explored.

Objective of the course are three-fold. For one, the participants shall learn to question aesthetic certainties and received modes of perception of cinematic, aesthetic art. Secondly they will be acquainted with the huge potential of films as a historical source to grasp processes of social and cultural change. Besides, the reconstruction of the international career of a specific variety of art and entertainment will also raise important questions of cultural globalization and consumerism. As a side-effect, a sit were, the students will also be provided with important insights into the chequered history of the Indian subcontinent in during the course of the 20th century.

Literature
Zur Einführung:


Prerequisites / notice
A detailed course description and session plan will be available from 15 Sept 2013 onwards at http://www.gmw.ethz.ch/education

851-0101-53L Collections in Context: What Do Historians and Scientists Learn from Butterflies, Stones, and Bones? W 3 credits 2S B. Schär, M. Greeff

Abstract
Zurich holds huge scientific collections. They contain objects from around the world, some of them dating back to the 18th century. This interdisciplinary seminar combines perspectives from the history of science and from current scientific disciplines. What do these objects tell us about Zurich's place in the global history of science? What potentials do old collections hold for scientists today?

Objective
The aim of this seminar is threefold: Firstly, students will become familiarized with historiographical approaches to scientific collections. Among them are constructivist approaches that seek to understand scientific knowledge not primarily as a system of objective truths, but rather as an outcome of human 'constructions'. Other approaches deal with the problem of how scientific objects are related to systems of power and oppression, namely in the case of objects collected during the time of European colonialism overseas. Secondly, students will become familiarized with how old collections can yield new insights for current scientists working, e.g., on questions of ecology. Thirdly, the seminar shall serve as a platform to discuss ways of dialogue and possible collaboration between these different approaches.

Students will be expected to read theoretical texts and case studies during semester, participate in discussions with external experts (historians, curators, and scientists), and to write a summarizing essay at the end of the term.


Abstract
Bruno Latour (* 1947) is one of the most important contemporary sociologist of science. He enriched our understanding of what a scientific fact is and how we get to it, i.e. how it is made up, not only discovered. Latour defends a constructivist approach to reality. What that exactly means, will be clarified in this course.

Objective
- Introduction into the sociology of science of Bruno Latour, esp. the Agent/Network/Theory.
- Understanding main topics of sociology and philosophy of science.

851-0157-67L Creativify Number of participants limited to 40. W 3 credits 2S M. Wulz, V. Wolff

Abstract
Being creative may appear to be the most important requirement of the present age: creative thinking, start-ups, project development all seem to promise an ongoing innovation of work and life. Instead of repeating that promise once again, this course asks for the historical conditions of discourses of creativity.

Objective
We will deal with historical and contemporary theories of inventive imagination, fantasy, and creativity. Looking at artistic, psychological, pedagogical, economic, and entrepreneurial discourses of creativity from the 18th to the 21st century we will discuss their specific contexts in order to uncover historical differences and changes. Is it indeed possible to identify conjunctions between the economization, scientification and normalization of creativity? Are there any alternatives to the reigning paradigm of creativity? And if so, what are those?


Abstract
This seminar deals with the past, present, and imaginary futures of scientific publishing. We shall discuss the origins and trajectories of specific formats, conventions, and genres as well as examine exemplary historical developments as regards scientific publishing and associated cultures of science.

Objective
The technological upheavals wrought by the "digital age" have put the subject of scientific publishing on the map (again). Open access, copyright, or print-on-demand are just a few of the buzzwords that have defined controversies in recent years. The aim of this seminar is to assist students in developing critical perspectives on these contemporary debates - by learning about the history of scientific publishing, including the role of specific publishers and journals, the footnote, or the malleable nature of authorship.

851-0157-70L The Mathematics of Scientific Racism W 2 credits 1S A. Telicher

Abstract
How did racial scientists determine racial affiliation? In the seminar we will examine the practical challenges and eventual works of physical anthropologists from 1850 to the present. By scrutinizing the scientific toolbox of racial scientists, we will reveal how national affiliation, anti-Semitic perceptions and Gender identity shaped scholars' choices of graphical and computational methods.

Objective
The aim of the course is to analyze the mutual relations between scientific theories and social perceptions, and to follow the formation of the "scientific mind". The course focuses on racial scientists and on the way their practices of computation and statistical analysis influenced their world-views - and vice versa. The students will be instructed on the way historians of science analyze scientific sources. They will gain a better understanding of the complexities of disciplinary dynamics, social biases and institutional pressures shaping scientific ideas, and learn on the influences such scientific ideas may have on the society as a whole.

Prerequisites / notice
Please note that the seminar will be held in English and most texts will be in English. However, a small portion of the reading material will be in German.

851-0157-69L History of Astronomy W 3 credits 2S S. Mastorakou
<table>
<thead>
<tr>
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<th>Course Title</th>
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<td>The Art of Conversation</td>
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<td>851-0331-06L</td>
<td>The Secretaries of the Baroque Age and the “Honest Dissimulation”</td>
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<td>862-0002-16L</td>
<td>Research Colloquium History of Knowledge (HS 2016)</td>
<td>2</td>
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<td>A. Kilcher, K. M. Espahangizi, D. Gugerli, M. Hagner, P. Sarasin, J. Tanner,</td>
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<td>Only for MAGPW students, D-GESS PHD and D-ARCH PHD students.</td>
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<td>851-0125-63L</td>
<td>Images of Mathematics</td>
<td>3</td>
<td>W</td>
<td>M. Hampe, A. Schubbach</td>
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**Abstract**

The course is designed to provide an overview of the astronomical developments from the ancient Greek world to the 16th century. We are going to use primary sources tackling historical, technical and philosophical questions. Special attention will be paid to the dramatic change in the way people understood the structure of the heavens and the nature of the physical world.

**Objective**

The course aims at providing a working knowledge of astronomy and cosmology from the ancient world to the 16th century. Upon its completion the students will be able to describe how our knowledge of the heavens changed from Aristotle’s system to the Copernican Revolution. In addition, they will also have acquired an appreciation of the debates about man’s place in the cosmos and the philosophical principles underpinning cosmology.

**Prerequisites / notice**

Credit points can be gained by regular attending and by writing an essay. In addition to the five colloquia there will be a deepening seminar on offer (lecturer K. Espahangizi).

Free childcare available.
How we understand Mathematics is probably strongly influenced by the Mathematics lessons we participated in during our school days. The common image of mathematics is therefore often characterized by the impression of a very stable form of knowledge with clear-cut problems and suitable recipes for finding the solution. It is a very static image which is very much in conflict with the rapid series of innovations that the discipline has experienced especially since the 19th century: Mathematics as a field of research has been highly innovative and even revolutionary as few other scientific disciplines in the last 200 hundred years.

These mathematical innovations did not only contribute to a progress amassing more and more knowledge. They very often changed how mathematicians conceived of their discipline. Even a contribution to a specific research question that appears at first sight to be minor can sometimes establish new connections to other fields, found a whole research field of its own or introduce new methods thereby changing the whole image of mathematics in the same way that a small addition to a picture can alter radically what we take it to represent.

The lecture series "Images of Mathematics" deals with a few moments in the history of the scientific discipline since the middle of the 19th century when the image of mathematics changed. In particular, it focuses on the consequences of the fact that in the 19th century mathematics started to not only reflect on their own conceptual and methodological foundations in a general manner (which had been done since the dawn of mathematics and was especially a philosophical task), but to formalize them in a strict, mathematical way: the objects of mathematics, its logical language and its proof procedures. Through Cantor's set theory, the mathematical treatment of logic since Boole and especially through Frege and the formalization of its axioms in a wide ranging discussion involving Zermelo, Fraenkel and others, this self-reflexive stance came to the fore.

Yet, the deeper mathematicians dug into its foundations, the more radical the problems became. Finally, the optimistic Hilbert program laying the foundation of mathematics within mathematics and of proving its own consistency as well as its completeness contributed to clarifying of the foundation of mathematics primarily as if it was doomed to failure. Gödel proved his famous incompleteness theorems and thereby dismissed at the same time the formalist attempt to reduce mathematical truth to logical provability. His work resulted in detailed insights in the precariousness of the foundation of mathematics and further numerous of productive consequences within mathematics.

Moreover, Gödel's theorems open many far-reaching and intriguing questions in view of our image of mathematics, questions concerning the conception of mathematical practice and knowledge, the limits of calculability of mathematics and the possible role of computability and machines in mathematics, the relation of logic to mathematics, the logical proof procedures and the involved intuitive aspects. In short, the image of mathematics is not as static as we sometimes expect it to be, it was radically redrawn by the mathematicians of the 20th century and has since then again been open to diverging interpretations.

For further reading (optional): Mark van Atten and Juliette Kennedy, Gödel's Logic, in: Handbook of the History of Logic, Vol 5: Logic from 3 credits 2S

M. Hampe

On the one hand modells of machines had a heuristical value in research on man, e.g. in Harvey's discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these modells were always criticised, sometimes polemically, because they are supposedly not adequate for man.

From Plato, Aristotle and Cicero, philosophers have tried to find the core principle of wit (or the joke, as both meanings are contained in the German term "Witz"). Even during the 20th century, the philosophy of life and psychoanalysis struggle with it. The seminar provides an overview of this history.

Instead, these approaches understand literature in terms of its epistemological forms and functions. Thus, the main thesis is that literature and especially through Frege and the formalization of its axioms in a wide ranging discussion involving Zermelo, Fraenkel and others, this self-reflexive stance came to the fore.

Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

Content

- The Knowledge of Literature. An Introduction
  - W 3 credits 2V A. Kilcher
  - A. Kilcher

851-0300-85L

This lecture provides a general introduction to literary theory and presents the important theories dealing with knowledge and its role in and as literature.

Objective

- Students are introduced to the various approaches and methods of literature studies and gain an overview of literary theory.

Content

- This lecture has two aims: Firstly, it serves as a general introduction into the field of literary theory (thereby looking into "knowledge about literature"). Secondly, there will be a special emphasis on recent theoretical approaches particularly in literary and knowledge as one of its components (thus investigating the "knowledge of literature"). Even though traditional criticism disagrees, a number of recent approaches, based on literature and culture studies, hold that literature is not to be conceived of as standing in opposition to the world and the classificatory system of the academic disciplines, particularly the sciences (e.g. Foucauldian discourse analysis and New Historicism).

Instead, these approaches understand literature in terms of its epistemological forms and functions. Thus, the main thesis is that literature actively participates in the constitution and formation of knowledge. Literature itself generates models of knowledge, sometimes with critical or even utopian intentions. Moreover, it draws attention to the fundamental role of order and representation (systematization, narrative rendering, linguistic and pictorial representation) in both humanities and sciences.

851-0300-79L

Theories of Joke

- W 3 credits 2S A. Kilcher

Abstract

- From Plato, Aristotle and Cicero, philosophers have tried to find the core principle of wit (or the joke, as both meanings are contained in the German term "Witz"). Even during the 20th century, the philosophy of life and psychoanalysis struggle with it. The seminar provides an overview of this history.

Objective

- This seminar deals with the meaning and history of "Witz" (wit, joke) as a form of knowledge. It places "Witz" as a switch or transitional figure within the development of modern theories of knowledge in particular.

Content

- Contrary to intuitive expectations, the German term "Witz" is not only an instance of the comical, but also a form of knowledge that plays on similarity and difference by juxtaposing the disparate. In this vein, especially during the 17th and 18th centuries, "Witz" becomes a central attribute of poetic and rhetorical types of expression (wit). Only during the 19th century and especially through Frege and the formalization of its axioms in a wide ranging discussion involving Zermelo, Fraenkel and others, this self-reflexive stance came to the fore.

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Cognition in Studio Design - Analytic Tools for Evidence-Based Design

Objective
Taking the perspectives of the end user (occupants and visitors) is vital for a human-centered design approach. Students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to address human cognitive and behavioral needs in built environments. The foundations of environmental psychology and human spatial cognition will be introduced. A focus of the course will be on how people perceive their surroundings and orient in space. Students will learn about a range of methods including real-world observation, and methods of architectural analysis such as space syntax. Students will also be exposed to behavior simulation in design, virtual reality experiments, and eye-tracking. Students will reflect the roles of designers and other stakeholders with respect to human-centered design as well as an evidence-based design perspective. The course is tailored for students from a relevant design studio. Upon registering, students should send an email about their design studio to b.emo@gess.ethz.ch. As an alternative to obtaining D-GESS credit, architecture students can obtain course credit in "Vertiefungsfach" or "Wahlfach".

Evolutionary Foundations of Social Behavior

Objective
This course explores selected topics of cognitive neuroscience. The course begins with a basic introduction to the field covering neural anatomy and brain physiology. Contemporary methods used in neuroscientific research (e.g., fMRI, EEG) will also be introduced and their benefits and limits critically reviewed. Using this knowledge, we will discuss some of the classic works in neuroscience in visual perception, memory and emotion. This will be accompanied by some famous cases of patients demonstrating problems in these domains (e.g., people with agnosia or amnesia). Further topics will include the cognitive and neural processes involved in pain processing, the placebo effect, as well as spatial representation and navigation. This course targets students at the Bachelor level with no previous experience. The main requirement for this course is an open and critical mind. By the end of the course, the student will be able to identify the major brain structures and to explain the basic functioning of neurons as well as some of the fundamental principles of how our brain works. Students should have an understanding of the methods used to generate the various findings reported in the literature and the media. The course aims to enable and encourage the students to critically evaluate these findings, and what can and cannot be answered with neuroscience techniques. For each of the topics, students should be able to identify the phenomenon, give examples, and discuss one or two of the main theories explaining it.

Special Topics in Cognitive Neuroscience

Objective
This course explores selected topics of cognitive neuroscience. This is a lecture with an exercise. You will receive an in-depth overview of the application of Darwinian theory on behavioral phenomena. This will enable you to approach the heuristic perspective of the so-called adaptationist program of social phenomena. Finally, you will be able to discern the benefits and the problems of the evolutionary perspective within various scientific disciplines, especially anthropology, psychology, empirical social research and comparative cultural sciences. This course is open to all Ph.D. (and Master students) who are interested in conducting (behavioral) economic experiments.

Doctoral Department of Humanities, Social and Political Sciences - Key for Type

Table:<br>W+ ELigible for credits and recommended: Z Courses outside the curriculum<br>W ELigible for credits: Dr Suitable for doctorate<br>E- Recommended, not eligible for credits: O Compulsory<br>V lecture: P practical/laboratory course<br>G lecture with exercise: A independent project<br>U exercise: D diploma thesis<br>S seminar: R revision course / private study<br>K colloquium: ECTS European Credit Transfer and Accumulation System<br>Special students and auditors need special permission from the lecturers.

Prerequisites / notice The class is open to all Ph.D. (and Master students) who are interested in conducting (behavioral) economic experiments.
### Doctoral and Post-Doctoral Courses

#### Health Sciences and Technology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1791-00L</td>
<td>Introductory Course in Neuroscience I (University of Zurich)</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>J.M. Fritschy, W. Nenech</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: SPV0Y005</td>
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<td>Mind the enrolment deadlines at UZH:</td>
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<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>The course gives an introduction to human and comparative neuroanatomy, molecular, cellular and systems neuroscience.</td>
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<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>1) Human Neuroanatomy I&amp;II</td>
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<td>2) Comparative Neuroanatomy</td>
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<td>3) Development I&amp;II</td>
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<td>4) Membran and Action Potential</td>
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<td>5) Synaptic Transmission &amp; Plasticity I&amp;II</td>
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<td></td>
<td>6) Glia and Blood-Brain-Barrier</td>
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<td></td>
<td>7) Somatosensory and Motor System</td>
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<td>8) Visual System</td>
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<td>9) Auditory System</td>
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<td>10) Circuits underlying Emotion</td>
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<td></td>
<td>11) Modeling of Neural Circuits</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>For doctoral students of the Neuroscience Center Zurich (ZNZ).</td>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-1795-00L</td>
<td>Advanced Course in Neurobiology I (Functional Anatomy of the Rodent Brain) (University of Zurich)</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>J.M. Fritschy, H. U. Zeilhofer</td>
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<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: SPV0Y009</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.</td>
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<td><strong>Objective</strong></td>
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<td>This credit point course is designed for doctoral students who have successfully completed the Introductory Course in Neuroscience at the Neuroscience Center Zürich. The goal is to provide students with a broader and deeper knowledge in several important areas of neurobiology.</td>
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<td><strong>Prerequisites / notice</strong></td>
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### Food Science

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-0005-00L</td>
<td>Public Colloquium in Food Science</td>
<td>E-</td>
<td>1 credit</td>
<td>2K</td>
<td>S. J. Sturla</td>
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<tr>
<td></td>
<td>Participation in weekly seminars on a variety of topics including Food Microbiology, Food Toxicology, Food Biochemistry, Food Processing, Consumer Behavior, Food Technology, and Food Materials and Technology, and oral presentation of a selected published study in one of these areas inspired by participation in the seminars.</td>
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<td><strong>Objective</strong></td>
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<td>The objectives are to become familiar with and stimulate interest in leading-edge science related to the research topics of the Institute of Food, Nutrition and Health. Participants attend weekly seminars given by external and internal speakers, and are also required to deliver a presentation on a recent research article inspired by a topic from the semester presentations.</td>
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**Doctoral Department of Health Sciences and Technologies - Key for Type**

- **W+** Eligible for credits and recommended
- **W** Eligible for credits
- **E-** Recommended, not eligible for credits
- **Z** Courses outside the curriculum
- **Dr** Suitable for doctrate
- **O** Compulsory

**Key for Hours**

- **P** practical/laboratory course
- **A** independent project
- **D** diploma thesis
- **R** revision course / private study

**ECTS** European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.

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Data: 06.11.2018 12:57  Autumn Semester 2016  Page 434 of 1571
Doctoral and Post-Doctoral Courses

Doctoral Department of Computer Science


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0912-00L</td>
<td>Experimental Computer Systems</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>T. Gross</td>
</tr>
</tbody>
</table>

Abstract

This graduate seminar provides doctoral students in computer science a chance to discuss their research. Enrollment requires permission of the instructor. Credit units are granted only to active participants.

Objective

Learn how to formulate a research project, how to conduct research and how to improve presentation skills in an academic setting.

Content

The seminar will explore different topics from a research perspective. The seminar is open to assistants of the Department of Computer Science (Informatik), Computer Systems Institute. Others should contact the instructor.

Lecture notes

Supporting material will be distributed during the seminar.

Prerequisites / notice

Credit will be given only to those who present a paper/project. No credit for "attendance".

Course Catalogue of ETH Zurich

252-0923-00L

OMS Case Study I

Abstract

This doctoral seminar consists of a series of talks and discussions covering the history and foundations of OMS, related work and on-going OMS developments and applications.

Objective

The seminar will explore different topics from a research perspective.

252-0932-00L

Seminar on Cryptography

Abstract

Latest Topics in Cryptography will be discussed.

Objective

The seminar will explore different topics from a research perspective.

252-0933-00L

Algorithms and Complexity (HS)

Abstract

The seminar treats selected problems of current interest in the area of algorithms and complexity.

Objective

Develop an understanding of selected problems of current interest in the area of algorithms and complexity.

Content

This seminar treats selected problems of current interest in the area of algorithms and complexity.

Lecture notes

None

Literature

Research papers, to be chosen in the seminar.

Prerequisites / notice

Prerequisites: Basic understanding of algorithms and complexity.

252-0945-03L

Doctoral Seminar Machine Learning (HS16)

Abstract

An essential aspect of any research project is dissemination of the findings arising from the study. Here we focus on oral communication, which includes: appropriate selection of material, preparation of the visual aids (slides and/or posters), and presentation skills.

Objective

The seminar participants should learn how to prepare and deliver scientific talks as well as to deal with technical questions. Participants are also expected to actively contribute to discussions during presentations by others, thus learning and practicing critical thinking skills.

Prerequisites / notice

Only for Ph.D. students.

252-4202-00L

Seminar in Theoretical Computer Science

Abstract

Presentation of recent publications in theoretical computer science, including results by diploma, masters and doctoral candidates.

Objective

The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.

252-1425-00L

Geometry: Combinatorics and Algorithms

Abstract

Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)

Objective

The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains. In particular, we want to prepare students for conducting independent research, for instance, within the scope of a thesis project.

Content

Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in R^d, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting polygon triangulations.

Lecture notes

yes

Literature


Prerequisites / notice

Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH.

Outlook: In the following spring semester there is a seminar "Geometry: Combinatorics and Algorithms" that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.

263-2100-00L

Research Topics in Software Engineering

Abstract

This seminar is an opportunity to become familiar with current research in software engineering and more generally with the methods and challenges of scientific research.

Objective

Each student will be asked to study some papers from the recent software engineering literature and review them. This is an exercise in critical review and analysis. Active participation is required (a presentation of a paper as well as participation in discussions).
Content
The aim of this seminar is to introduce students to recent research results in the area of programming languages and software engineering. To accomplish this, students will study and present research papers in the area as well as participate in paper discussions. The papers will span topics in both theory and practice, including papers on program verification, program analysis, testing, programming language design, and development tools. A particular focus will be on domain-specific languages.

Prerequisites / notice
The publications to be presented will be announced on the seminar home page at least one week before the first session.

Organizational note: the seminar will meet only when there is a scheduled presentation. Please consult the seminar's home page for information.

264-5800-08L
Doctoral Seminar in Visual Computing (HS16)

W 1 credit 1S
M. Gross, O. Sorkine Hornung

Abstract
This graduate seminar provides doctoral students in computer science a chance to read and discuss current research papers. Enrollment requires permission of the instructors. Credit units are granted only to active participants.

Objective
Learn about current research results in the area of Visual Computing, practice of scientific presentations.

Content
Current research at the IVC will be presented and discussed.

264-5810-00L
Programming Languages Seminar

W 2 credits 2S
P. Müller, M. Vechev

Abstract
This graduate seminar provides doctoral students in computer science a chance to read and discuss current research papers. Enrollment requires permission of the instructors. Credit units are granted only to active participants.

Objective
Learn about current research results in the area of programming languages, static program analysis, program verification, and related areas; practice of scientific presentations.

Content
The seminar will explore different topics from a research perspective.

Lecture notes
Supporting material will be distributed during the seminar.

151-0906-00L
Frontiers in Energy Research

W 2 credits 2S
M. Mazzotti, R. S. Abhari, J. Carmeliet, M. Filippini

Abstract
PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.

Objective
Knowledge of advanced research in the area of energy.

Content
PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community. Every week there are two presentations, each structured as follows: 15 min introduction to the research topic, 15 min presentation of the results, 15 min discussion with the audience.

Lecture notes
Slides will be distributed.

263-2900-00L
How To Give Strong Technical Presentations

Z 0 credits
M. Püschel

Objective
Wherever possible I illustrate by example and present the material in a way to make it immediately applicable. The goal is to provide the knowledge that enables the participants, whether beginner or experienced presenter, to further improve their presentation skills and hence their impact whenever they step in front of an audience.

Content
This course covers all aspects of delivering strong presentations. I explain common mistakes, what works and what does not, and why. Then I discuss structure and content as well as a set of fundamental principles from graphic design that make slides communicate effectively. These principles also apply to the presentation and visualization of data which is covered in some detail. Finally, I give some useful tips on the use of Powerpoint that simplify the creation of strong presentations.

264-5812-00L
Writing for Publication in Computer Science (WPCS)

Z 0 credits 1G
S. Milligan

Abstract
This short course is designed to help junior researchers in Computer Science develop the skills needed to write their first research articles. The course deals with topics such as:
- understanding the needs of different target readerships,
- managing the writing process efficiently,
- structuring texts effectively,
- producing logical flow in sentences and paragraphs,
- editing texts before submission, and
- revising texts in response to colleagues' feedback and reviewers' comments.

Objective
Writing for Publication in Computer Science is a short course (5 x 4-lesson workshops) designed to help doctoral students develop the skills needed to write their first research articles. The course deals with topics such as:
- understanding the needs of different target readerships,
- managing the writing process efficiently,
- structuring texts effectively,
- producing logical flow in sentences and paragraphs,
- editing texts before submission, and
- revising texts in response to colleagues' feedback and reviewers' comments.

Content
Participants will be expected to produce a number of short texts (e.g., draft of a conference abstract) as homework assignments; they will receive individual feedback on these texts during the course. Wherever feasible, elements of participants' future conference/journal articles can be developed as assignments within the course, so it is likely to be particularly useful for those who have i) their data and are about to begin the writing process, or ii) an MSc thesis they would like to convert for publication.

Doctoral Department of Computer Science - Key for Type

<table>
<thead>
<tr>
<th>W+</th>
<th>Eligible for credits and recommended</th>
<th>Z</th>
<th>Courses outside the curriculum</th>
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<tbody>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>O</td>
<td>Compulsory</td>
</tr>
</tbody>
</table>

Key for Hours

| V  | lecture                             | P | practical/laboratory course    |
| G  | lecture with exercise               | A | independent project            |
| U  | exercise                            | D | diploma thesis                 |
| S  | seminar                             | R | revision course / private study |
| K  | colloquium                          |   |                                 |

ECTS
- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
Doctoral Dep. of Information Technology and Electrical Engineering


► Doctoral and Post-Doctoral Courses

A minimum of 12 ECTS credit points must be obtained during doctoral studies.

The courses on offer below are but a small selection out of a much larger available number of courses. Please discuss your course selection with your PhD supervisor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
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<td>151-0906-00L</td>
<td>Frontiers in Energy Research</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Mazzotti, R. S. Abhari, J. Carmeliet, M. Filipini</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.</td>
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<td></td>
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<td>Slides will be distributed.</td>
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<tr>
<td>227-0225-00L</td>
<td>Linear System Theory</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>M. Kamgarpour</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.</td>
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<td>Objective</td>
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<td>By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.</td>
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<tr>
<td></td>
<td>Content</td>
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<td>- Rings, fields and linear spaces, normed linear spaces and inner product spaces.</td>
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<td>- Ordinary differential equations, existence and uniqueness of solutions.</td>
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<td>- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.</td>
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<td>- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.</td>
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<td>- Stability and stabilization, observers, state and output feedback, separation principle.</td>
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<td></td>
<td>- Realization theory.</td>
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<td></td>
<td>Slides will be distributed.</td>
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<tr>
<td></td>
<td>Prerequisites: Control Systems I (227-0103-00) or equivalent and sufficient mathematical maturity.</td>
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<tr>
<td>227-0389-00L</td>
<td>Advanced Topics in Magnetic Resonance Imaging</td>
<td>Z</td>
<td>0</td>
<td>1V</td>
<td>K. P. Prüssmann</td>
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<td></td>
<td>Abstract</td>
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<td>This course is geared towards master and PhD students with a focus on bioimaging. It covers advanced topics in magnetic resonance imaging in biennial rotation, including the electrodynamics of MR signal detection, noise mechanisms, image reconstruction, radiofrequency pulse design, RF pulse trains, as well as advanced contrast mechanisms.</td>
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<td>Objective</td>
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<td>By the end of the course students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.</td>
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<td></td>
<td>Content</td>
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<td>- Rings, fields and linear spaces, normed linear spaces and inner product spaces.</td>
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<td>- Ordinary differential equations, existence and uniqueness of solutions.</td>
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<td>- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.</td>
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<td>- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.</td>
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<td>- Stability and stabilization, observers, state and output feedback, separation principle.</td>
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<td>- Realization theory.</td>
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<td>Lecture notes</td>
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<td>Slides will be distributed.</td>
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<td>Prerequisites: Control Systems I (227-0103-00) or equivalent and sufficient mathematical maturity.</td>
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<tr>
<td>227-0417-00L</td>
<td>Information Theory I</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>A. Lapidoth</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>This course covers the basic concepts of information theory and of communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.</td>
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<td>Objective</td>
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<td>By the end of the course students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.</td>
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<td>Lecture notes</td>
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<td>Prerequisites: Control Systems I (227-0103-00) or equivalent and sufficient mathematical maturity.</td>
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<tr>
<td>227-0427-00L</td>
<td>Signal and Information Processing: Modeling, Filtering, Learning</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>H.A. Loeliger</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>Fundamentals in signal processing, detection/estimation, and machine learning.</td>
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<tr>
<td></td>
<td>I. Linear signal representation and approximation: Hilbert spaces, LMMSE estimation, regularization and sparsity.</td>
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<td>Objective</td>
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<td>By the end of the course students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.</td>
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<tr>
<td>227-0455-00L</td>
<td>Terahertz: Technology &amp; Applications</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>K. Sankaran</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting.</td>
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<tr>
<td></td>
<td>Objective</td>
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<td>This is an introductory course on Terahertz (THz) technology and applications. Devices operating in THz frequency range (0.1 to 10 THz) have been increasingly studied in the recent years. Progress in nonlinear optical materials, ultrafast optical and electronic techniques has strengthened research in THz application developments. Due to unique interaction of THz waves with materials, applications with new capabilities can be developed. In theory, they can penetrate somewhat like X-rays, but are not considered harmful radiation, because THz energy level is low. They should be able to provide resolution as good or better than magnetic resonance imaging (MRI), possibly with simpler equipment. Imaging, very-high bandwidth communication, and energy harvesting are the most widely explored THz application areas. We will study the basics of THz generation, manipulation, and detection. Our emphasis will be on the physical principles and applications of THz in the domain of imaging, communication and energy harvesting.</td>
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</table>

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 437 of 1571
Theory and techniques for the identification of dynamic models from experimentally obtained system input-output data.

Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, K. E. Stephan

Introduction to modeling: Black-box and grey-box models; Parametric and non-parametric models; ARX, ARMAX (etc.) models. J. M. Buhmann


Selected topics of the current research activities at the IEF and closely related institutions are discussed. A. Steger, E. Welzl

Machine learning provides analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects. J. M. Buhmann

Whenever we deviate from the main material discussed in these books, softcopy of lectures notes will be provided. Good foundation in electromagnetics & knowledge of microwave or optical communication is helpful.
Lecture notes: No lecture notes, but slides will be made available on the course webpage.

Literature:

Prerequisites / notice: The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

<table>
<thead>
<tr>
<th>227-0559-00L</th>
<th>Seminar in Distributed Computing</th>
<th>W</th>
<th>2 credits</th>
<th>2S</th>
<th>R. Wattenhofer</th>
</tr>
</thead>
</table>

Abstract: In this seminar participating students present and discuss recent research papers in the area of distributed computing. The seminar consists of algorithmic as well as systems papers in distributed computing theory, peer-to-peer computing, ad hoc and sensor networking, or multi-core computing.

Objective: In the last two decades, we have experienced an unprecedented growth in the area of distributed systems and networks; distributed computing now encompasses many of the activities occurring in today's computer and communications world. This course introduces the basics of distributed computing, highlighting common themes and techniques. We study the fundamental issues underlying the design of distributed systems: communication, coordination, synchronization, uncertainty. We explore essential algorithmic ideas and lower bound techniques.

In this seminar, students present the latest work in this domain.

Seminar language: English

Content: Different each year. For details see: www.disco.ethz.ch/courses.html

Lecture notes: Slides of presentations will be made available.

Literature: Papers. The actual paper selection can be found on www.disco.ethz.ch/courses.html.

Course Catalogue of ETH Zurich

Doctoral Dep. of Information Technology and Electrical Engineering - Key for Type

| W+ | Eligible for credits and recommended | Z | Courses outside the curriculum |
| W  | Eligible for credits                | Dr | Suitable for doctorate        |
| E- | Recommended, not eligible for credits | O | Compulsory                    |

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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ECTS: European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Doctoral Department of Management, Technology, and Economics

Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-1036-00L</td>
<td>Empirical Innovation Economics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Wörter</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course focuses on important factors that drive the innovation performance of firms, like innovation capabilities, science-industry relationships, environmental policy and it shows how innovation activities relate to firm performance and to the technological dynamic of industries. Hence, the course provides an understanding of the relationship between technical change and industrial dynamics.</td>
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<tr>
<td>Objective</td>
<td>The course provides students with the basic skills to understand and assess empirically the technological activities of firms and the technological dynamics of industries.</td>
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<tr>
<td>Content</td>
<td>The course consists of two parts. Part I provides an introduction into important topics in the field of the economics of innovation. Part II consists of empirical exercises based on the KOF Innovation Data. In part I we will learn about ...a) market conditions that encourage firms to invest in R&amp;D (Research and Development) and develop new products. ...b) the role of universities for the technological activities of a firm (technology transfer). ...c) how technologies diffuse among firms. ...d) how the R&amp;D activities of firms are affected by economic crises and how firms finance their R&amp;D activities. ...e) how we can measure the returns to R&amp;D activities. ...f) how (environmental) policies affect the technological activities of a firm. In part II we will use the KOF Innovation Survey Data in order to assess empirically the technological activities of firms referring to the topics introduced in part I.</td>
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<tr>
<td>Lecture notes</td>
<td>Will be provided in the course</td>
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<tr>
<td>Literature</td>
<td>Literature will be presented in the course. For an introduction into the economics of innovation see G.M. Peter Swann, The Economics of Innovation - an Introduction, Edward Elgar, 2009. For an overview of empirical innovation studies see W.M. Cohen (2010): Fifty Years of Empirical Studies of Innovation Activities and Performance, in: B.H Hall, N. Rosenberg (eds.), Handbook of Economics of Innovation, volume 1, Elsevier, pp. 129-213.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Course is directed to advanced Master-Students and PhD Students with an interest in empirical work.</td>
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364-0531-00L  CER-ETH Research Seminar  E-  0 credits  2S  H. Gersbach, A. Bommier, L. Bretschger, W. Mimra

Abstract  Understanding cutting-edge results of current research in the fields of the CER-ETH Professors.
Content  Bitte spezielle Ankündigungen beachten.
Prerequisites / notice  Studierende des GESS-Pflichtwahlfachs sollten sich vor Beginn mit der Seminarleitung in Verbindung setzen.

364-0553-00L  Innovation in the Digital Space  W  1 credit  1G  G. von Krogh

Abstract  The purpose of this course is to review and discuss issues in current theory and research relevant to innovation in the digital space.
Objective  Through in-depth analysis of published work, doctoral candidates will identify and appraise theoretical and empirical studies, formulate research questions, and improve the positioning of their own research within the academic debate.
Content  The Internet has a twofold impact on the way individuals and firms innovate. First, firms increasingly draw on digital technology to access and capture innovation-relevant knowledge in their environment. Second, individuals, firms, and other organizations extensively utilize the Internet to create, diffuse, and commercialize new digital products and services. During the past decade, theory and research on innovation in the digital space has flourished and generated extensive insights of relevance to both academia and management practice. This has brought us better understanding of working models, and some fundamental reasons for innovation success or failure. A host of new models and research designs have been created to explore the innovation in the digital space, but these have also brought out many open research questions. We will review some of the existing streams of work, and in the process explore a new research agenda.
Format  The course is organized in one block of 2 days. The course is a combination of pre-readings, presentations by faculty and students, and discussions. The students prepare presentations of papers in order to facilitate analysis and discussion.
Innovation, openness and search:

Open source and innovation models:

Motivation to Innovate:

Leadership and Governance:

364-0559-00L Dynamic Macroeconomics (Doctoral Course)  W  3 credits  2V  H. Gersbach

Objective
Dynamic models and workhorses in macroeconomics

Abstract
In this doctoral course, we learn dynamic general equilibrium theory and the basic workhorses in macroeconomics. After the course the participants will be able to speak the Arrow-Debreu and recursive language and apply the frameworks to interesting issues in Growth, Public Finance, Monetary Theory and Banking.

Content
1. Introduction
2. The Arrow-Debreu Approach and Sequential Markets
3. The Neoclassical Growth Model and the Representative Agent Model
4. Mathematical Background
5. Frictions and Banking
5.1 Overview
5.2 Banks in Macroeconomic Models
5.3 Ramsey cum Banks: General Equilibrium with Banks and Outside Equity
6. Overlapping Generations Models and Models with Heterogenous Agents
7. Debates
7.1 Theory of Piketty
7.2 High Bank Equity Requirements

364-0556-00L Doctoral Workshop: Astute Modelling  W  3 credits  1G  H. Gersbach

Abstract
In this workshop, ongoing research is presented and the criteria and guidelines for astute modelling of economic, political, and social situations are discussed.

Prerequisites / notice
Students are expected to attend the doctoral course "Macroeconomic Dynamics" before registering for this workshop.

364-0585-01L PhD Course: Applied Econometrics  W  2 credits  2S  P. Egger

Abstract
In this course, we will address three blocs of selected problems: (i) estimation of fixed and random effects panel data models for single equations and systems of equations; (ii) estimation of models with endogenous treatment effects or sample selection; (iii) estimation of models with interdependent data (so-called spatial models).

Objective
The main agenda of this course is to familiarize students with the estimation of econometric problems with three alternative types of problems: (i) estimation of fixed and random effects panel data models for single equations and systems of equations; (ii) estimation of models with endogenous treatment effects or sample selection; (iii) estimation of models with interdependent data (so-called spatial models). Students will be able to program estimation routines for such problems in STATA and apply them to data-sets. They will be given a data-set and will have to work out empirical problems in the context of a term paper.
Lecture notes

For panel data analysis, I will rely on the book:

For sample selection and endogenous treatment effect analysis, I will rely on the book:

For spatial econometrics:
I will mostly use papers.

I will prepare a script (based on slides), covering all topics.

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>364-0517-00L</td>
<td>Urban and Spatial Economics</td>
<td>W</td>
<td>3</td>
<td>R. H. van Nieuwkoop</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course explores the economic factors which influence location decisions of households and firms, and it explores theories of how these decisions induce the formation of cities. The course will cover the neoclassical models of land use, concepts from the new economic geography, zoning, and transportation and traffic congestion.</td>
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<tr>
<td>Prerequisite</td>
<td>one semester in microeconomics.</td>
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<tr>
<td>Objective</td>
<td>The objective of the course is to provide graduate students with an understanding of the economic factors which give rise to urban spatial structure and the models which have been employed to study these processes. The course aims to help students develop an appreciation for the use of economic models in both positive and normative frameworks. We will assess both the history of thought regarding the role of markets in creating urban development, and we will read about modern theories of externalities and economic factors which induce agglomeration. The final section of the course will focus on transportation problems in urban areas and the use of economic models to assess public policy measures to deal with congestion and associated externalities.</td>
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<tr>
<td>Content</td>
<td>Outline of Lectures</td>
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<tr>
<td>Lecture notes</td>
<td>Textbook</td>
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<td></td>
<td>o Urban Economics by Arthur O'Sullivan, McGraw-Hill.</td>
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<td></td>
<td>o The new introduction to geographical economics, Steven Brakman, Harry Garretsen and Charles van Marrewijk, Cambridge.</td>
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<th>Instructor</th>
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<tbody>
<tr>
<td>364-0581-00L</td>
<td>Microeconomics Seminar (ETH/UZH)</td>
<td>E-</td>
<td>0</td>
<td>H. Gersbach</td>
</tr>
<tr>
<td>Abstract</td>
<td>Research Seminar research papers of leading researchers in Microeconomics are presented and discussed</td>
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<tr>
<td>Objective</td>
<td>Research Seminar research papers of leading researchers in Microeconomics are presented and discussed</td>
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<tr>
<td>Content</td>
<td>Invited Speakers present current research in Microeconomics</td>
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<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
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<tr>
<td>364-1013-00L</td>
<td>Managerial Cognition</td>
<td>W</td>
<td>1</td>
<td>S. Brusoni</td>
</tr>
<tr>
<td>Abstract</td>
<td>The primary objective of this module is to introduce some of the major theoretical threads and controversies in the field of managerial cognition. A secondary objective is to help understand the process of empirical research that has the potential to make an impact on research and management practice.</td>
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<td>Objective</td>
<td>The module will seek to provide: 1) Exposure to key theoretical streams in the area. 2) Familiarity with the issues, methods, findings and gaps in the area. 3) Skills in finding insight in the literature. 4) Skills in critiquing the literature, defining research problems and proposing empirical research in this area.</td>
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</table>
| Content       | Session 1 - Introduction to the field of managerial cognition  
Session 2 - Methods to study managerial cognition  
Session 3 - Sensemaking, Mindfulness and Attention |
Perspectives on Organizational Knowledge

Session 1: Introduction

This module aims to introduce major theoretical perspectives on organizational knowledge and to improve the competence of doctoral students to publish in relevant research areas. How knowledge is conceptualized and what aspects of knowledge are being studied depends on the epistemological and ontological assumptions accepted by researchers.

Prerequisites / notice

Assignments: At the beginning of each session, students must distribute copies of their critique of the assigned reading (please see your names at the end of each reference). The critique should be brief, extending to a maximum of one printed page. The critique is meant to serve as a starting point for the student to lead the class in a discussion of the strengths and weaknesses of the paper. For each session, students should emphasize the following topics in their critique:

Session 1: Introduction


Session 2: Some methods to study managerial cognition


Session 3: Sensemaking, Mindfulness and Attention


Assignments: At the beginning of each session, students must distribute copies of their critique of the assigned reading (please see your names at the end of each reference). The critique should be brief, extending to a maximum of one printed page. The critique is meant to serve as a starting point for the student to lead the class in a discussion of the strengths and weaknesses of the paper. For each session, students should emphasize the following topics in their critique:

Session 1:
- summarize the research problem or question
- summarize the central framework/ theory that is proposed
- list the strengths of the paper (you can use bulletpoints)
- list the weaknesses of the paper (you can use bulletpoints)

Session 2:
- Same as for session 1 with particular emphasis on the pros and cons of the method used
- Propose at least one alternative methodology and explain why you think the alternative method(s)would have been better suited

Session 3:
- three bullet points summarizing the paper strengths
- three bullet points summarizing the paper weaknesses
- prepare a one-page research idea: what would be a new research question? how would you extend the paper? what could be counterintuitive results?

Please contact Dr Daniella Laureiro Martinez for more information on this course.
This module aims:

- to provide a basic understanding of key theoretical perspectives on organizational knowledge.
- to provide insights on the research questions, methods, findings and implications of the selected papers.
- to build skills in critically analyzing the literature.
- to identify future directions.

Content

Given its prominence in the history of organization science, an impressive variety of theories have evolved that deals with organizational epistemology, the way of knowing in the organization (e.g., Brown & Duguid, 1991; Grant, 1996; Kogut & Zander, 1992; Lave & Wenger, 1991; Nonaka, 1994; Spender, 1996; Tsoukas, 1996; von Krogh et al., 1994). In this module, students will learn about various seminal contributions in the area of organizational knowledge and make connections between theory and empirical research, and identify the ongoing trends and future research directions.

Session 1: Knowledge based view of the firm.
Session 2: Knowledge sharing and transfer
Session 3: Social practice view on knowledge and knowing

Literature

Remark: The list might change. Students will be informed about the changes before the first session.

Prerequisites / notice

In each session, students will have three assignments:

1) prepare for in-depth discussion of all papers. The students are supposed to read in advance all the papers that will be presented in the sessions.
2) critically review and discuss the assigned papers. Assignments will be done after participants confirm their presence.
3) submit in advance a short critique of the assigned papers - max 2 pages.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>364-1013-01L</td>
<td>Organizations and Technical Change</td>
</tr>
</tbody>
</table>

Abstract

This 1-credit module is designed to introduce students to selected topics focused on the relationship between technical change and organizational dynamics.

Objective

The objectives of this module are:

1) to provide students with a relatively detailed understanding of some of the major theoretical perspectives and their developments in the field of innovation and technical change
2) to illustrate how these perspectives have evolved
3) to discuss how they can be operationalized
4) and, on these bases, develop the ability of constructively criticising them in order to learn how ‘to build upon and extend’ extant research in the field

Content

Session 1: Technology rules. Once upon a time, people believed that technology determines organization. What techniques we use explain how we organize around them. If there is no fit to the technique, then there is failure. Powerful, simple, predictive, engineer-friendly. Occasionally correct, too.

Session 2: Never Mind the Bollocks ... Once upon a time, people believed that technologies were fully malleable to social dynamics. Marxists, social constructivists and management gurus (still) share great optimism in the human ability of solving technical problems, once the right organizational processes are in place. Revolutionary, ambitious, path-breaking. Occasionally baffling, though.

Session 3: It takes two to tango: Technological and organizational dynamics. And last, the big compromise, or the balance finally found? It is not white. It is not black. But it is not grey either. Pragmatic, practical, progressive. Relevant? Actionable?
In the first class, current understanding of the marketing literature and marketing thought is discussed.

Risk Center Seminar Series

A. Bommier

The objective of the course is to provide students with advanced knowledge in some areas of micro economic theory. The course will focus on:


On each session, students will have two assignments: 1) prepare a summary and critique of at least one of the readings for the day; 2) come prepared to critically discuss all the readings for the day. For the critique, readings will be preassigned in advance of each sessions.

Further info on assignments will be circulated by email before the start of the course.

Session 1.

Session 2. Never Mind the Bollocks: organizations rule.

Organizational Behavior

W 1 credit 1S

E. L. Paddock, G. Grote

Organizational behavior concerns the study of individual and group-level processes in organizations like creativity, motivation, decision-making, and leadership. In this module an overview of major research streams and empirical paradigms in organizational behavior is provided.

Marketing Theory

W 1 credit 1G

F. von Wangenheim

The course is taught Florian Wangenheim (ETHZ)

It focuses on the theoretical foundations of marketing and marketing research.

Advanced Microeconomics

E- 3 credits 2G

A. Bommier

The objective of the course is to provide students with advanced knowledge in some areas of micro economic theory. The course will focus on:


The aim is to give to the students the opportunity to review the key results in rational individual behavior, collective models, choice under uncertainty, intertemporal choice, as well as to get some insights on more recent advances in those areas.

The course is therefore designed for students who have some interest for research in economics.

Risk Center Seminar Series

Number of participants limited to 50.

Z 0 credits 2S


This course is a mixture between a seminar primarily for PhD and postdoc students and a colloquium involving invited speakers. It consists of presentations and subsequent discussions in the area of modeling complex socio-economic systems and crises. Students and other guests are welcome.

Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop novel mathematical models for open problems, to analyze them with computers, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to work scientifically on an internationally competitive level.

This course is a mixture between a seminar primarily for PhD and postdoc students and a colloquium involving invited speakers. It consists of presentations and subsequent discussions in the area of modeling complex socio-economic systems and crises. For details of the program see the webpage of the colloquium. Students and other guests are welcome.
In this seminar series, which is held jointly with Prof. Dr. Woitek and Prof. Dr. Hoffman from the University of Zurich, distinguished experts from the fields of international economic policy will present their current research related to international economic policy. The participating doctoral students are expected to attend the presentations (bi-weekly). Moreover, a critical review has to be prepared for 1 of the papers presented. On the one hand, participating students are exposed to research at the frontier of international economic policy research. On the other hand, skills such as critical thinking and preparing reviews are learned.

**Objective**

The purpose of this course is to
- introduce students to the world of economics, management and systems research at MTEC
- make students aware of silo-thinking in the specific subdisciplines and encourage them to go beyond those silos
- discuss current issues with regard to substantive, methodological and theoretical domains of research in the respective fields

**Literature**

Books:

Basic Articles:

A reading list with articles for each lecture has been published in Moodle.

**Prerequisites / Notice**

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

- UZH Module Code: DOEC0584
- Mind the enrolment deadlines at UZH:

For further information, please consult the course webpage.

**Course Catalogue of ETH Zurich**

**Doctoral Department of Management, Technology, and Economics - Key for Type**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Notes</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>O</td>
</tr>
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</table>

**Data: 06.11.2018 12:57  Autumn Semester 2016  Page 446 of 1571**
Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS  European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0111-00L</td>
<td>Research Seminar in Fluid Dynamics</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>P. Jenny, T. Rösgen</td>
</tr>
<tr>
<td></td>
<td>Internal research seminar for graduate students and scientific staffs of the IFD</td>
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<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Current research projects at the Institute of Fluid Dynamics are presented and discussed.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Exchange on current internal research projects. Training of presentation skills.</td>
</tr>
<tr>
<td>151-0115-00L</td>
<td>Academia Industry Modeling Week (University of Zurich)</td>
<td>W</td>
<td>2</td>
<td>3S</td>
<td>University lecturers</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: ESC802</td>
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<td></td>
<td></td>
<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td>Focused research by teams of Master and PhD students as well as post-doctoral fellows on applied problems proposed by industrial partners. Industry representatives and participating faculty coordinate the formulation of the problem and supervise the research teams. Topics can cover all scientific interests and domains represented in the PhD program and in particular their interfaces.</td>
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<tr>
<td></td>
<td>Objective</td>
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<td>Training of presentation skills.</td>
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<td>Interface academia and industry.</td>
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<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>Team work on industrial problems.</td>
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<td>Permission of the PhD advisor and/or instructor.</td>
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<tr>
<td>151-0906-00L</td>
<td>Frontiers in Energy Research</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Mazzotti, R. S. Abhari, J. Carmellet, M. Filippini</td>
</tr>
<tr>
<td></td>
<td>This course is only for doctoral students.</td>
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<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
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<td></td>
<td></td>
<td>Knowledge of advanced research in the area of energy.</td>
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<tr>
<td></td>
<td>Content</td>
<td></td>
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<td></td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community. Every week there are two presentations, each structured as follows: 15 min introduction to the research topic, 15 min presentation of the results, 15 min discussion with the audience.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
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<td></td>
<td></td>
<td>Slides will be distributed.</td>
</tr>
<tr>
<td>151-1049-00L</td>
<td>Seminar in Fundamentals of Process Engineering</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Rudolf von Rohr</td>
</tr>
<tr>
<td></td>
<td>Only for master and doctoral students of Process and Chemical Engineering.</td>
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<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>This seminar covers actual subjects from the specific research areas of the laboratory of transport processes and reactions.</td>
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<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Scientific discussion on actual research topics.</td>
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<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>The contents are announced through the group's webpage.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>No textbook</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Current advanced research activities in the areas of thermo- and fluid dynamics are presented and discussed, mostly by external speakers. Knowledge of advanced research in the areas of thermo- and fluid dynamics.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Knowledge of advanced research in the areas of thermo- and fluid dynamics.</td>
</tr>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Koumoutsakos</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 60.</td>
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<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Knowledge of advanced research in the areas of thermo- and fluid dynamics.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.</td>
</tr>
<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
<td></td>
<td>1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
<td>2. Probability Theory: The Logic of Science by E. T. Jaynes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3. Class Notes</td>
</tr>
<tr>
<td>151-0107-20L</td>
<td>High Performance Computing for Science and Engineering (HPCSE) I</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>M. Troyer, P. Chatzidoukas</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.</td>
</tr>
</tbody>
</table>

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The course is focused on providing students with the knowledge and understanding required to develop simple computational fluid dynamics (CFD) codes to solve the incompressible Navier-Stokes equations and to critically assess the results produced by CFD codes. As part of the course, students will write their own codes and verify and validate them systematically.

### Content

1. Governing and model equations. Brief review of equations and properties
2. Overview of basic concepts: Overview of discretization process and its consequences
3. Overview of numerical methods: Finite-difference and finite-volume methods
4. Analysis of spatially discrete equations: Consistency, accuracy, stability, convergence of semi-discrete methods
5. Time-integration methods: LMS and RK methods, consistency, accuracy, stability, convergence
6. Analysis of fully discrete equations: Consistency, accuracy, stability, convergence of fully discrete methods
7. Solution of one-dimensional advection equation: Motivation for and consequences of upwinding, Godunov's theorem, TVD methods, DRP methods
8. Solution of two-dimensional advection equation: Dimension-by-dimension methods, dimensional splitting, multidimensional methods
9. Solution of one- and two-dimensional diffusion equations: Implicit methods, ADI methods
10. Solution of one-dimensional advection-diffusion equation: Numerical vs. physical viscosity, boundary layers, non-uniform grids
11. Solution of incompressible Navier-Stokes equations: Incompressibility constraint and consequences, fractional-step and pressure-correction methods
12. Solution of incompressible Navier-Stokes equations on unstructured grids

### Literature

4. Koulouros, D. J. Norris, and H.M. Prasser, A. Steinfield

### Prerequisites / notice

- fluid mechanics, thermodynamics, heat and mass transfer
- electrical engineering / electronics
- numerical data analysis and processing (e.g. using MATLAB)

### Objective

1. Students know and understand basic numerical methods used in CFD in terms of accuracy and stability.
2. Students have a basic understanding of a typical simple CFD code.
3. Students understand how to assess the numerical and physical accuracy of CFD results.
4. Students can develop simple CFD codes and validate them.
5. Students can critically assess the results produced by CFD codes.

### Target audience

- Electrical engineering / electronics
- Fluid mechanics, thermodynamics, heat and mass transfer

### Assessment

A final exam evaluates the acquired knowledge individually. Lab reports for all attended experiments have to be submitted by the study groups. Research areas of the participating institutes (fluid dynamics, energy technology, process engineering) are attended by students in small groups.

### Literature


### Prerequisites

- Electrical engineering / electronics
- Fluid mechanics, thermodynamics, heat and mass transfer

### Assessment

A final exam evaluates the acquired knowledge individually. Lab reports for all attended experiments have to be submitted by the study groups. Research areas of the participating institutes (fluid dynamics, energy technology, process engineering) are attended by students in small groups.

### Literature

This course consists of a series of seven lectures given by researchers who have distinguished themselves in the area of Robotics, Systems, and Controls. Please see http://www.msrl.ethz.ch/education/distinguished-seminar-in-robotics--systems---controls--151-0623-0.html for a suggestion of other seminar related to the field and submit a one page description of the seminar topic. Please see http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html for a list of upcoming lectures.

This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: marischm@ethz.ch)

Officially this course consists of seven lectures given by researchers who have distinguished themselves in the area of Robotics, Systems, and Controls. MSc students in Robotics, Systems, and Controls are required to attend every lecture. Attendance will be monitored. If for some reason a student cannot attend one of the lectures, the student must select another ETH or University of Zurich seminar related to the field and submit a one page description of the seminar topic. Please see http://www.msr.ethz.ch/education/distinguished-seminar-in-robotics--systems---controls--151-0623-0.html for a suggestion of other lectures.

The course "Leading and Coaching Focus Project Teams (Basic Course)" for Autumn Semester is examined together with the course "Leading and Coaching Focus Project Teams (Advanced Course)" for Spring Semester with 4 ECTS.
Abstract
Aim is enhancement of knowledge and competency regarding coaching skills. Participants should be coaches of focus projects. Topics:
Overview of the role and mind set of a coach, introduction into coaching methodology, building competencies by doing and exchanging good practices from former focus projects.

Objective
Basic knowledge about role and mindset of a coach;
Knowledge and reflection about the classical problems in coaching of a focus project;
Development of personal coaching skills;
Knowledge and how about coaching methods;
Reflection and exchange of experiences about personal coaching situations;
Inspiration and learning from good cases regarding organizational and team management aspects.

Content
Content of both basic and advanced course (2 semester):
- Basic knowledge about role and mindset of a coach
- Introduction into coaching: definition & models
- Introduction into the coaching process
- Role of coaches between examiner and "friend"
- Knowledge and reflection about the problems in coaching a focus project
- Knowledge about team development
- Reflection about critical phases in the innovation process for an innovation team
- Know-how about reference model for analysis critical situations
- Development of personal coaching competencies, e.g. active listening, asking questions, giving feedback
- Competencies in theoretical models
- Coaching competencies: exercises and reflection

Knowledge and know-how about coaching methods:
- Knowledge about basic coaching methods for technical projects/innovations projects
- Know-how about usage of methods in the coaching process
- Facilitating decisions
- Using and applying coaches opinions and knowledge
- Reflection and exchange of experiences about personal coaching situations
- Self-reflection
- Exchange of experiences in the lecture group
- Good practice on organizational and management aspects
- How to do system and concurrent engineering
- Project planning and replanning
- Facilitating conflict situations
- Discussing sample cases from former teams and actual cases of participants.

Lecture notes
Slides, script and other documents will be distributed via electronically (access only for participants registered to this course).

Literature
Please refer to lecture script.

Prerequisites / notice
Participants (Students, PhD Students, Postdocs) should be part of the coaching team of focus project teams.

The course "Leading and Coaching Focus Project Teams (Basic Course)" (HS) is examined together with "Leading and Coaching Focus Project Teams (Advanced Course)" (FS) in FS with 4 ECTS.

151-0833-00L Principles of Nonlinear Finite-Element-Methods

W 5 credits 2V+2U N. Manopulo, B. Berisha, P. Hora

Abstract
Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.

Objective
The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:

- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations

Content
- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

Lecture notes
yes

Literature

Prerequisites / notice
If we will have a large number of students, two dates for the exercises will be offered.

351-0778-00L Discovering Management


Abstract
Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.
Objective
Discovering Management combines in an innovative format a set of lectures and an advanced business game. The learning model for Discovering Management involves 'learning by doing'. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow.

This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.

Content
Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the interdependence of various topics in the development and management of a firm. The lectures introduce students not only to topics relevant for managing large corporations, but also touch upon the different aspects of starting up your own venture. The lectures will be presented by the respective area specialists at D-MTEC.

The course broadens the view and understanding of technology by linking it with its commercial applications and with society. The lectures are designed to introduce students to topics related to strategy, corporate innovation, leadership, corporate and entrepreneurial finance, value chain analysis, corporate social responsibility, and business model innovation. Practical examples from industry experts will stimulate the students to critically assess these issues. Creative skills will be trained by the business game exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of Chief Innovation Officer of a large multinational company. As they learn more about the specific case and identify the challenge they are faced with, the students will have to develop an innovative business case for this multinational corporation. Doing so, this exercise will provide an insight into the context of managerial problem-solving and corporate innovation, and enhance the students' appreciation for the complex tasks companies and managers deal with. The business game presents a realistic model of a company and provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyse the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

Prerequisites / notice
Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich.

No prior knowledge of business or economics is required to successfully complete this course.

363-0341-00L
Introduction to Management

Abstract
This course is an introduction to the critical management skills involved in planning, structuring, controlling and leading an organization.

Objective
We develop a 'systemic' view of organizations. We look at organizations as part of an industry context, which is affected by different elements like strategy, structure, culture, tasks, people and outputs.

Content
Further information is available on the Tim Group Chair's website: http://www.timgroup.ethz.ch/en/courses

and on the Moodle of the course: https://moodle-app2.etgh.ch/course/view.php?id=2209
(The Enrollment Key to Moodle will be provided during the course)

Lecture notes
The content of the course will rely on the book:

Selected readings from the book and additional learning materials will be available on the course Moodle: https://moodle-app2.etgh.ch/course/view.php?id=2209

Prerequisites / notice
The final exam of the present course is in written form.

The final exam is requested for all types of students (BSc, MSc, MA, PhD, and Exchange students). It is not possible to retake the exam within the same term or academic year.

We strongly recommend Exchange students to take it into consideration when selecting the courses to attend.

363-0389-00L
Technology and Innovation Management

Abstract
This course focuses on the analysis of innovation as a pervasive process that cut across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.

Objective
This course intends to enable all students to:
- understand the core concepts necessary to analyze how innovation happens
- master the most common methods and tools organizations deploy to innovate
- develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation

Content
This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success are small.

How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.

Lecture notes
Slides will be available on the TIMGROUP website.

Literature
Readings will be available on the TIMGROUP website.

Prerequisites / notice
No specific background in economics or management is required.

363-0403-00L
Introduction to Marketing

Abstract
The course is designed to convey a profound understanding of marketing's role in modern firms, its interactions and interfaces with other disciplines, its main instruments and recent trends. Particular attention is given to emerging marketing concepts and instruments, and the role of marketing in technology firms.
The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2467) contains announcements, course content, objective, literature, and prerequisites.

### Objective
After taking the lecture, students should have knowledge on:
1. The definition and role of marketing (marketing basics)
2. Creating marketing insights - understanding customer behavior
   - Theoretical concepts in customer behavior (customer behavior)
   - Analytical means to extend knowledge on customer behavior (marketing research)
   - Strategic tools to quantify customer behavior (CLV, CE)
3. Strategic marketing - translating marketing insights into actionable marketing strategies
   - Segmentation, Targeting, and Positioning
   - Attracting customers (marketing mix, 4Ps)
   - Maintaining profitable customer relations (CRM)

### Content
The course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?

### Literature

Weekly readings, distributed in class (via Moodle)

### Literature

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Prerequisite / Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0503-00L</td>
<td>Principles of Microeconomics</td>
<td>3</td>
<td>G</td>
<td>M. Filippini</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course introduces basic principles, problems and approaches of microeconomics.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>(1) Students must be able to discuss basic principles, problems and approaches in microeconomics. (2) Students can analyse and explain simple economic principles in a market using supply and demand graphs. (3) Students can contrast different market structures and describe firm and consumer behaviour. (4) Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole. (5) Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Lecture notes, exercises and reference material can be downloaded from Moodle.</td>
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<tr>
<td>Literature</td>
<td>The book can also be used for the course ‘Principles of Macroeconomics’ (Sturm)</td>
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</tr>
<tr>
<td>363-0511-00L</td>
<td>Managerial Economics</td>
<td>4</td>
<td>V</td>
<td>S. Rausch, V. Hoffmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Managerial Economics applies economic theory and methods to business and economic decision-making. Economic ideas related to optimization, the theory of consumer demand, the theory of the firm, industrial organization and decision making under uncertainty are studied using methods of numerical analysis, statistical estimation, game theory and constrained optimization.</td>
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<tr>
<td>Objective</td>
<td>The objective of the course is to provide undergraduate and graduate students in MAVT with an understanding of the use of economic concepts for firm-level management decisions. The course covers a number of models and methods of analysis which are commonly employed in business decisions. The course covers the economic theory of choice, models of oligopoly and industrial organization, applications of game theory to contract design and agency theory, and the theory of decision making under uncertainty focusing specifically on long-term investment decisions. The course will include three lectures by Professor Volker Hoffman focusing on related case-studies in management.</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Mikróökonómia (Pearson Studium - Economic VWL) Gebundene Ausgabe, August 2013, Robert S. Pindyck, Dr. Daniel L. Rubinfeld.</td>
<td></td>
<td></td>
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<tr>
<td>Prerequisites</td>
<td>The course acquaints students who have previous not studied economics to economic concepts and quantitative methods which can be used to solve management decision problems.</td>
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<tr>
<td>363-0565-00L</td>
<td>Principles of Macroeconomics</td>
<td>3</td>
<td>V</td>
<td>J.E. Sturm</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?</td>
<td></td>
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<tr>
<td>Objective</td>
<td>This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer. Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.</td>
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<tr>
<td>Lecture notes</td>
<td>The course webpage (to be found at <a href="https://moodle-app2.let.ethz.ch/course/view.php?id=2467">https://moodle-app2.let.ethz.ch/course/view.php?id=2467</a>) contains announcements, course information and lecture slides.</td>
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<tr>
<td>Literature</td>
<td>We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).</td>
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<tr>
<td></td>
<td>Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.</td>
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<tr>
<td>363-0711-00L</td>
<td>Accounting for Managers</td>
<td>3</td>
<td>V</td>
<td>M. Passardi</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course introduces basic accounting principles, concepts, and methods. Students will learn how to prepare and analyze financial statements, evaluate financial performance, and understand the role of accounting in decision-making.</td>
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</tr>
<tr>
<td>Objective</td>
<td>(1) Students must be able to prepare and interpret financial statements. (2) Students must be able to analyze financial data and make informed business decisions. (3) Students must be able to evaluate financial performance and make recommendations for improvement.</td>
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<tr>
<td></td>
<td>We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).</td>
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</table>

Data: 06.11.2018 12:57   Autumn Semester 2016   Page 453 of 1571
This lecture will introduce the fundamentals of monetary economics and explain the working and impact of monetary policy.

W. J. E. Sturm
U. Claesson

Knowledge in the field of intellectual property, especially of patents and trademarks, with particular emphasis on pharmaceutics.


Understand the different procedures involved in the accounting system
Overview of financial and managerial accounting
The course will be based on chapters of:
A. Koepf

Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by

Social, political and ethical aspects (patents and prices for medicinal products, traditional knowledge and ethnomedicine, bioprospecting and biopiracy, human DNA inventions);
5. Peculiarities in pharmaceutics and medicine (supplementary protection certificates, experimental use exemption, therapy and diagnosis,
4. Exploitation and enforcement of patents (possibilities of exploitation, licenses, parallel imports, scope of protection, patent infringement);
3. Patent information (patent publications, databases, searches);
2. Prosecution of patent applications (patentability);
1. Introduction into industrial property (patents, trademarks, industrial designs);

This course offers theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures.
ISBN 13: 978-1-29-209418-4

A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.
This course will introduce the fundamentals of monetary economics and explain the working and impact of monetary policy.
The course will be based on chapters of:

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ISBN 13: 978-1-29-209418-4

A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.
A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.
Objective

The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

Content

Presentations on advanced synthetic biology topics (e.g., genetic circuit design, adaptation of systems dynamics, analytical concepts, large-scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Lecture notes

Handouts during course

Prerequisites / notice

The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

851-0180-00L Research Ethics

Particularly suitable for students of D-BIOL, D-CHAB, D-HEST

Abstract

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective

The main goal of this course is to enhance the student’s ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional, and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry
---------------------------------------

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)
----------------------------------------------------------

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access;
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.
### Doctoral Department of Mechanical and Process Engineering - Key for Type

| W+ | Eligible for credits and recommended |
| W  | Eligible for credits |
| E- | Recommended, not eligible for credits |
| Z  | Courses outside the curriculum |
| Dr | Suitable for doctorate |
| O  | Compulsory |

### Key for Hours

| V  | lecture |
| G  | lecture with exercise |
| U  | exercise |
| S  | seminar |
| K  | colloquium |
| P  | practical/laboratory course |
| A  | independent project |
| D  | diploma thesis |
| R  | revision course / private study |

### ECTS

- European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0710-00L</td>
<td>Polymer Physics</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>H. C. Öttinger, M. Kröger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Group seminar in polymer physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Continued and deeper education in polymer physics, in particular, for Ph.D. students</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Presentation and discussion of ongoing research projects by members of the polymer physics group and external speakers</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>No script</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Irregular series of presentations (see announcements)</td>
<td></td>
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</tr>
<tr>
<td>327-0711-00L</td>
<td>Metal Physics and Technology Seminar</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>J. F. Löffler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Seminar for Ph.D. students and researchers in the area of metal physics and technology</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Detailed education of researchers in the area of metallic materials</td>
<td></td>
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<tr>
<td>Content</td>
<td>Presentation and discussion of latest research results concerning basic principles of metals research and development of new metallic materials</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>- Requirements: Involvement in research activities.</td>
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<td></td>
<td>- Lectures are generally in English.</td>
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<tr>
<td>327-0712-00L</td>
<td>Nanometallurgy Seminar</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>R. Spolenak</td>
</tr>
<tr>
<td>Abstract</td>
<td>Seminar for Ph.D. students and researchers in the area of nanometallurgy</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Detailed education of researchers in the area of nanometallurgy</td>
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<tr>
<td>327-1300-00L</td>
<td>Joint Group Seminar</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>M. Fiebig, N. Spaldin</td>
</tr>
<tr>
<td>Abstract</td>
<td>Seminar for PhD students and researchers in condensed-matter physics</td>
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<tr>
<td>Objective</td>
<td>Improving the interaction of researchers in the participating groups</td>
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<tr>
<td>Content</td>
<td>Presentation and discussion of contemporary research</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Own scientific contributions.</td>
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<tr>
<td>327-0721-00L</td>
<td>Writing for Publication in Materials Science</td>
<td>Dr</td>
<td>2</td>
<td>1G</td>
<td>R. Mihalka</td>
</tr>
<tr>
<td>Number of participants limited to 15.</td>
<td>Only for D-MATL doctoral students</td>
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<tr>
<td>Abstract</td>
<td>This short course is designed to help junior researchers in Materials Science develop the skills needed to write their first research articles.</td>
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<tr>
<td>Objective</td>
<td>Writing for Publication in Materials Science is a short course (5 x 4-lesson workshops) designed to help junior researchers develop the skills needed to write their first research articles. The course deals with topics such as</td>
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<td></td>
<td>- identifying target readerships and selecting outlets,</td>
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<td></td>
<td>- managing the writing process efficiently,</td>
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<td>- structuring the text effectively,</td>
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<td>- producing logical flow in sentences and paragraphs,</td>
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<tr>
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<td>- editing the text before submission, and</td>
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<td>- revising the text in response to reviewers' comments.</td>
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<tr>
<td>Content</td>
<td>Participants will be expected to produce a number of short texts as homework assignments and will receive individual feedback on these during the course. Wherever feasible, elements of participants' future research articles can be developed as assignments within the course, so it is likely to be particularly useful for those who have their data and are about to begin the writing process.</td>
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<tr>
<td></td>
<td>Part 1: Introduction to the course; the writing context; identifying target readers and targeting journals; using model texts; activating vocabulary; writing clear English sentences; the English verb system in research publications - using tense, aspect, and voice</td>
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<td>Part 2: The writing process; structural decisions (IMRD and variations); from plan to draft; basics of paragraph structure; reader-friendly paragraph structure; patterns and tools for creating logical flow; the English noun phrase in research publications</td>
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<td>Part 3: The experimental narrative; process descriptions, explanation and justification; data commentaries; embedding figures, diagrams, etc.</td>
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<td></td>
<td>Part 4: Introductions; creating a research space (CARS); writing about the literature; reference, citation, paraphrase and quotation; discussion and conclusion sections; overview of abstracts and titles</td>
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<td></td>
<td>Part 5: Managing the strength of the claim - hedging and emphasis; punctuation and style; the editing process; responding to reviewers’ comments; preparing writing portfolios for assessment and research articles for submission.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>This short course is designed to help junior researchers in Materials Science develop the skills needed to write their first research articles.</td>
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<tr>
<td>151-0906-00L</td>
<td>Frontiers in Energy Research</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Mazzotti, R. S. Abhari,</td>
</tr>
<tr>
<td>Abstract</td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.</td>
<td></td>
<td></td>
<td></td>
<td>J. Carmeliet, M. Filippini</td>
</tr>
<tr>
<td>Objective</td>
<td>Knowledge of advanced research in the area of energy.</td>
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<tr>
<td>Content</td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community. Every week there are two presentations, each structured as follows: 15 min introduction to the research topic, 15 min presentation of the results, 15 min discussion with the audience.</td>
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<tr>
<td>Lecture notes</td>
<td>Slides will be distributed.</td>
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### Doctoral Department of Materials Science - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<td>O</td>
<td>Compulsory</td>
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### Key for Hours

<table>
<thead>
<tr>
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<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

### ECTS

ECTS: European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Nachdiplom lecture

A. Shnirelmann

Ideal incompressible fluid is one of the most fundamental models in the continuum mechanics. The fluid flow is described by the Euler-Lagrange equations which, in spite of their apparent simplicity, are among the toughest in the whole mathematics. No wonder that the study of these equations involves many different mathematical structures, and requires a stereoscopic approach to capture the full picture. In these lectures I'll propose various viewpoints on the fluid. Here are the topics of the lectures:

1. Analyticity properties of the flows of the ideal incompressible fluid. Complex singularities, their persistence and propagation.
3. Two-point problem for the Euler-Lagrange equations. Surjectivity of the exponential map in 2-d, and pathologies in 3-d.
5. Generalized flows and weak solutions of the Euler equations. Models of turbulent cascade.

The objective is to introduce students in mathematics and physics to an area of study of nonlinear systems of equations in two independent variables, in particular the Euler equations of compressible fluids with plane symmetry and the Einstein equations of general relativity with spherical symmetry.

The course begins with characteristics, the definition of hyperbolicity, causal structure and the domain of dependence theorem. The course then focuses on nonlinear systems of equations in two independent variables, in particular the Euler equations of compressible fluids with plane symmetry and the Einstein equations of general relativity with spherical symmetry.

The objective is to introduce students in mathematics and physics to an area of mathematical analysis involving differential geometry which is of fundamental importance for the development of classical macroscopic continuum physics.

The course shall begin with the basic structure associated to hyperbolic partial differential equations, characteristic hypersurfaces and bicharacteristics, causal structure, and the domain of dependence theorem. The course shall then focus on nonlinear systems of equations in two independent variables. The first topic shall be the Euler equations of compressible fluids under plane symmetry where we shall study the formation of shocks, and second topic shall be the Einstein equations of general relativity under spherical symmetry where we shall study the formation of black holes and spacetime singularities.

Basic real analysis and differential geometry.

In the most important part of the course, we will present the notion of Singular Integrals and Calderón-Zygmund theory as well as its application to the analysis of linear elliptic operators.

During the first lectures we will review the theory of tempered distributions and their Fourier transforms. We will go in particular through the notion of Fréchet spaces, Bannach-Steinhaus for Fréchet spaces etc. We will then apply this theory to the Fourier characterization of Hilbert-Sobolev spaces.

In the second part of the course we will study fundamental properties of the Hardy-Littlewood Maximal Function in relation with $L^p$ spaces. We will then make a digression through the notion of Marcinkiewicz weak $L^p$ spaces and Lorentz spaces. At this occasion we shall give in particular a proof of Aoki-Roelewicz theorem on the metrisability of quasi-normed spaces. We will introduce the preduals to the weak $L^p$ spaces, the Lorentz $L^{p,q}$ spaces as well as the general $L^{p,q}$ spaces and show some applications of these dualities such as the improved Sobolev embeddings.

In the third part of the main course, we will present the notion of Singular Integrals and Calderón-Zygmund theory as well as its application to the analysis of linear elliptic operators.

This theory will naturally bring us, via the so-called Littlewood-Paley decomposition, to the Fourier characterization of classical Hilbert and non Hilbert Function spaces which is one of the main goals of this course.

If time permits we shall present the notion of Paraproduct, Paracompositions and the use of Littlewood-Paley decomposition for estimating products and general non-linearities. We also hope to cover fundamental notions from integrability by compensation theory such as Coifman-Rochberg-Weiss commutator estimates and some of its applications to the analysis of PDE.

2) J. J. Duistermaat, "Fourier Analysis" AMS.
3) Loukas Grafakos, "Classical Fourier Analysis" GTM 249 Springer.
4) Loukas Grafakos, "Modern Fourier Analysis" GTM 250 Springer.
Prerequisites / notice
Notions from ETH courses in Measure Theory, Functional Analysis I and II (Fundamental results in Banach and Hilbert Space theory, Fourier transform of L^2 Functions)

401-4145-66L Reading Course: Abelian Varieties over Finite Fields  W  2 credits  4A  J. Fresán, P. S. Jossen

401-4147-66L Perfectoid Spaces  W  0 credits  2V  M. H. Hedayat Zadeh Razavi

Abstract
In this course we try to understand Peter Scholze's seminal paper on Perfectoid Spaces. We will cover in details (as much as time permits) the preliminary background from Huber's work on adic spaces, which provides the context for the basic constructions. Time permitting, we will also see how this theory leads to applications in p-adic étale cohomology.

Content
In this course we try to understand Peter Scholze's seminal paper on Perfectoid Spaces. We will cover in details (as much as time permits) the preliminary background from Huber's work on adic spaces, which provides the context for the basic constructions. Time permitting, we will also see how this theory leads to applications in p-adic étale cohomology.

The theory of perfectoid spaces provides functions, called tilting, between geometric objects in characteristic 0 and in characteristic p. In the zero dimensional case (fields) this essentially recovers a construction of Fontaine and Wintenberger that underlies p-adic Hodge theory: the absolute Galois group of an infinitely ramified p-adic field and that of the perfection of the corresponding Laurent series field (the tilted field) are canonically isomorphic. Subsequent works by Scholze have shown that perfectoid spaces are a powerful new tool across many aspects of arithmetic geometry.

401-3225-00L Introduction to Lie Groups  W  8 credits  4G  P. D. Nelson

Abstract
Topological groups and Haar measure. Definition of Lie groups, examples of local fields and examples of discrete subgroups; basic properties; Lie subgroups. Lie algebras and relation with Lie groups: exponential map, adjoint representation. Semisimplicity, nilpotency, solvability, compactness: Killing form, Lie's and Engel's theorems. Definition of algebraic groups and relation with Lie groups.

Objective
The goal is to have a broad though foundational knowledge of the theory of Lie groups and their associated Lie algebras with an emphasis on the algebraic and topological aspects of it.

Library
A. Knapp: "Lie groups beyond an Introduction" (Birkhaeuser)
A. Sagle & R. Walde: "Introduction to Lie groups and Lie algebras" (Academic Press, ’73)
F. Warner: "Foundations of differentiable manifolds and Lie groups" (Springer)
H. Samelson: "Notes on Lie algebras" (Springer, ’90)
S. Helgason: "Differential geometry, Lie groups and symmetric spaces" (Academic Press, ’78)

Prerequisites / notice
Topology and basic notions of measure theory. A basic understanding of the concepts of manifold, tangent space and vector field is useful, but could also be achieved throughout the semester.

Course webpage: http://www.math.ethz.ch/education/bachelor/lectures/hs2014/math/introlg

401-4531-66L Topics in Rigidity Theory  W  6 credits  3G  M. Burger

Abstract
The aim of this course is to give detailed proofs of Margulis’ normal subgroup theorem and his superrigidity theorem for lattices in higher rank Lie groups.

Objective
Understand the basic techniques of rigidity theory.

Content
This course gives an introduction to rigidity theory, which is a set of techniques initially invented to understand the structure of a certain class of discrete subgroups of Lie groups, called lattices, and currently used in more general contexts of groups arising as isometries of non-positively curved geometries. A prominent example of a lattice in the Lie group $\mathrm{SL}(n,\mathbb{R})$ is the group $\mathrm{SL}(n,\mathbb{Z})$ of integer $n \times n$ matrices with determinant 1. Prominent questions concerning this group are:
- Describe all its proper quotients.
- Classify all its finite dimensional linear representations.
- More generally, can this group act by diffeomorphisms on “small” manifolds like the circle?
- Does its Cayley graph considered as a metric space at large scale contain enough information to recover the group structure?

In this course we will give detailed treatment for the answers to the first two questions; they are respectively Margulis’ normal subgroup theorem and Margulis’ super-rigidity theorem. These results, valid for all lattices in simple Lie groups of rank at least 2 –like $\mathrm{SL}(n,\mathbb{R})$, with $n$ at least 3– lead to the arithmetically rigidity theorem, which says that all lattices are obtained by an arithmetic construction.

Library
- D. Witte-Morris: "Introduction to Arithmetic groups", available on Arxiv
- Y. Benoist: "Five lectures on lattices in semisimple Lie groups", available on his homepage.
- M. Burger: "Rigidity and Arithmeticity", European School of Group Theory, 1996, handwritten notes, will be put online.

Prerequisites / notice
For this course some knowledge of elementary Lie theory would be good. We will however treat Lie groups by examples and avoid structure theory since this is not the point of the course nor of the techniques.

401-3001-61L Algebraic Topology I  W  8 credits  4G  P. S. Jossen

Abstract
This is an introductory course in algebraic topology. The course will cover the following main topics: introduction to homotopy theory, homology and cohomology of spaces.

Literature

Book can be downloaded for free at: http://www.math.cornell.edu/~hatcher/AT/ATpage.html
See also: http://www.math.cornell.edu/~hatcher/#anchor1772800

Prerequisites / notice
Some knowledge of elementary topology and cohomology is needed.

401-3536-11L Geometric Aspects of Hamiltonian Dynamics  W  6 credits  3V  P. Biran

Abstract
The course will concentrate on the geometry of the group of Hamiltonian diffeomorphisms introduced by Hofer in the early 1990's and its relations to various topics in symplectic geometry such as capacities, Lagrangian submanifolds, holomorphic curves, as well as recent algebraic structures on the group of Hamiltonian diffeomorphisms such as quasi-morphisms.

Literature
Books:
* L. Polterovich: "The geometry of the group of symplectic diffeomorphisms"
* H. Hofer & E. Zehnder: "Symplectic invariants and Hamiltonian dynamics"

Prerequisites / notice
Prerequisites. Good knowledge of undergraduate mathematics (analysis, complex functions, topology, and differential geometry). Some knowledge of elementary algebraic topology would be useful.
401-4475-66L Partial Differential Equations and Semigroups of Bounded Linear Operators

Abstract
In this course we study the concept of a semigroup of bounded linear operators and we use this concept to investigate existence, uniqueness, and regularity properties of solutions of partial differential equations (PDEs) of the evolutionary type.

Objective
The aim of this course is to teach the students a decent knowledge (i) on semigroups of bounded linear operators, (ii) on solutions of partial differential equations (PDEs) of the evolutionary type, and (iii) on the analytic concepts used to formulate and study such semigroups and such PDEs.

Content
The course includes content (i) on semigroups of bounded linear operators, (ii) on solutions of partial differential equations (PDEs) of the evolutionary type, and (iii) on the analytic concepts used to formulate and study such semigroups and such PDEs. Key example PDEs that are treated in this course are heat and wave equations.

Prerequisites / notice
Mandatory prerequisites: Functional analysis.

Start of lectures: Friday, September 23, 2016
For more details, please follow the link in the Learning materials section.

401-4497-66L Free Boundary Problems

Abstract
The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Prerequisites / notice
The content of the basic courses of the first three years at ETH will be assumed. In particular, enrolled students are expected to be fluent both in Differential Geometry (at least at the level of Differentialgeometrie I, II) and Functional Analysis (at least at the level of Funktionalanalysis I, II). Some background on partial differential equations, mainly of elliptic and hyperbolic type, (say at the level of the monograph by L. C. Evans) would also be desirable.

Start of lectures: Wednesday, September 21, 2016
For more details, please follow the link in the Learning materials section.

401-4657-00L Numerical Analysis of Stochastic Ordinary Differential Equations

Abstract
Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

Objective
The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Prerequisites / notice
Mandatory: Probability and measure theory, basic numerical analysis and basics of MATLAB programming.

Start of lectures: Wednesday, September 21, 2016
For more details, please follow the link in the Learning materials section.
Participants of the course should become familiar with concepts underlying the discretization of elliptic and parabolic boundary value problems. Analytical techniques for investigating the convergence of numerical methods for the approximate solution of boundary value problems, methods for the efficient solution of discrete boundary value problems, implementation aspects of the finite element method.

A selection of the following topics will be covered:

- Elliptic boundary value problems
- Galerkin discretization of linear variational problems
- The primal finite element method
- Mixed finite element methods
- Discontinuous Galerkin Methods
- Boundary element methods
- Spectral methods
- Adaptive finite element schemes
- Singularly perturbed problems
- Sparse grids
- Galerkin discretization of elliptic eigenproblems
- Non-linear elliptic boundary value problems
- Discretization of parabolic initial boundary value problems

Course slides will be made available to the audience.

Practical exercises based on MATLAB
The course Combinatorics I and II is an introduction into the field of enumerative combinatorics.

**Lectures and Seminars**

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>401-3519-00L Mathematical Finance</strong></td>
<td>W</td>
<td>11</td>
<td>4V+2U</td>
<td>M. Schweizer</td>
</tr>
<tr>
<td><strong>402-0861-00L Statistical Physics</strong></td>
<td>W</td>
<td>10</td>
<td>4V+2U</td>
<td>G. Blatter</td>
</tr>
<tr>
<td><strong>403-3640-66L Monte Carlo and Quasi-Monte Carlo Methods:</strong></td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>C. Schwab</td>
</tr>
<tr>
<td><strong>404-4600-66L Student Seminar in Probability</strong></td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>A.S. Sznitman, J. Bertoin, P. Nolin, W. Werner</td>
</tr>
</tbody>
</table>

**Lecture notes / Literature / Prerequisites / notice**

- **401-3627-00L High-Dimensional Statistics:**
  - W 4 credits 2V P. L. Bühlmann
  - "High-Dimensional Statistics" deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.
  - Objective: Knowledge of methods and basic theory for high-dimensional statistical inference
  - Content: Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and 1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling
  - Prerequisites: Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

- **401-4889-00L Mathematical Finance:**
  - W 11 credits 4V+2U M. Schweizer
  - Advanced introduction to mathematical finance:
    - absence of arbitrage and martingale measures
    - option pricing and hedging
    - optimal investment problems
    - additional topics
  - Objective: Advanced level introduction to mathematical finance, presupposing knowledge in probability theory and stochastic processes
  - Content: This is an advanced level introduction to mathematical finance for students with a good background in probability. We want to give an overview of main concepts, questions and approaches, and we do this in both discrete- and continuous-time models. Topics include absence of arbitrage and martingale measures, option pricing and hedging, optimal investment problems, and probably others.
  - Prerequisites: Probability theory and stochastic processes (for which lecture notes are available).
  - Literature: Details will be announced in the course.

- **402-0861-00L Statistical Physics:**
  - W 10 credits 4V+2U G. Blatter
  - This lecture covers the concepts of classical and quantum statistical physics, and some aspects of kinetic gas theory and hydrodynamics.
  - Objective: This lecture gives an introduction in the basic concepts and applications of statistical physics for the general use in physics and, in particular, as a preparation for the theoretical solid state physics education.
  - Literature: Lecture notes available in german.
  - Literature: No specific book is used for the course. Relevant literature will be given in the course.

- **403-3640-66L Monte Carlo and Quasi-Monte Carlo Methods:**
  - W 4 credits 2S C. Schwab
  - Mathematical and Numerical Analysis
  - Number of participants limited to 6.
  - Content: Introduction and current research topics in the theory and implementation of Monte Carlo and quasi-Monte Carlo methods and applications.
  - Prerequisites: Completed courses Numerical Analysis of Elliptic/ Parabolic PDEs, or Numerical Analysis of Hyperbolic PDEs, or Numerical Analysis of Stochastic ODEs, and FAI, Probability Theory I.

- **404-4600-66L Student Seminar in Probability:**
  - W 4 credits 2S A.S. Sznitman, J. Bertoin, P. Nolin, W. Werner
  - Limited number of participants.
  - Registration to the seminar will only be effective once
The seminar is centered around a topic in probability theory which changes each semester. The student seminar in probability is held at times at the undergraduate level (typically during the spring term) and at times at the graduate level (typically during the autumn term). The themes vary each semester. The number of participants to the seminar is limited. Registration to the seminar will only be effective once confirmed by email from the organizers.

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**Colloquia**

<table>
<thead>
<tr>
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<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-5000-00L</td>
<td>Zurich Colloquium in Mathematics</td>
<td>E-</td>
<td>0 credits</td>
<td></td>
<td>W. Werner, P. L. Bühlmann, M. Burger, S. Mishra, R. Pandharipande, University lecturers</td>
</tr>
<tr>
<td>401-5990-00L</td>
<td>Zurich Graduate Colloquium (University of Zurich)</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

**Abstract**
The Graduate Colloquium is an informal seminar aimed at graduate students and postdocs whose purpose is to provide a forum for communicating one's interests and thoughts in mathematics.

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**Number Theory Seminar**

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-5110-00L</td>
<td>Number Theory Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>Ö. Imamoglu, P. S. Jossen, E. Kowalski, P. D. Nelson, R. Pink, G. Wüstholz</td>
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</tbody>
</table>

**Abstract**

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**Algebraic Geometry and Moduli Seminar**

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<th>Number</th>
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<tr>
<td>401-5140-11L</td>
<td>Algebraic Geometry and Moduli Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>2K</td>
<td>R. Pandharipande</td>
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**Abstract**

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**Geometry Seminar**

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<tr>
<td>401-5530-00L</td>
<td>Geometry Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>M. Burger, M. Einsiedler, U. Lang, University lecturers</td>
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**Abstract**

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**Analysis Seminar**

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<tbody>
<tr>
<td>401-5530-00L</td>
<td>Analysis Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>M. Struwe, A. Carlotto, D. Christodoulou, P. Da Lio, A. Figalli, N. Hungerbühler, T. Ilmanen, T. Kappeler, T. Rivière, D. A. Salamon</td>
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</table>

**Abstract**

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**Zurich Colloquium in Applied and Computational Mathematics**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>401-5580-00L</td>
<td>Symplectic Geometry Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>2K</td>
<td>D. A. Salamon, P. Biran, A. Cannas da Silva</td>
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**Talks in Mathematical Physics**

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<th>Number</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tr>
<td>401-5330-00L</td>
<td>Talks in Mathematical Physics</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>A. Cattaneo, G. Felder, M. Gaberdiel, G. M. Graf, H. Knörrer, T. H. Willwacher, University lecturers</td>
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**Seminar on Stochastic Processes**

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<tbody>
<tr>
<td>401-5600-00L</td>
<td>Seminar on Stochastic Processes</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>J. Bertoin, A. Nikeghbali, P. Nolin, B. D. Schlein, A.S. Sznitman, W. Werner</td>
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**Research Seminar on Statistics**

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<tr>
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<th>Lecturers</th>
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**Talks in Financial and Insurance Mathematics**

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<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-5910-00L</td>
<td>Talks in Financial and Insurance Mathematics</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>P. Cheridito, M. Schweizer, M. Soner, J. Teichmann, M. V. Wüthrich</td>
</tr>
</tbody>
</table>

**Optimization Seminar**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-5900-00L</td>
<td>Optimization Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>R. Weismantel, R. Zenklusen</td>
</tr>
</tbody>
</table>

**Seminar in Theoretical Computer Science**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>252-4202-00L</td>
<td>Seminar in Theoretical Computer Science</td>
<td>E-</td>
<td>2 credits</td>
<td>2S</td>
<td>E. Welzl, B. Gärtner, M. Hoffmann, J. Lengler, A. Steger, B. Sudakov</td>
</tr>
</tbody>
</table>

**Objective**
The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.
<table>
<thead>
<tr>
<th>Doctoral Department of Mathematics - Key for Type</th>
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</thead>
<tbody>
<tr>
<td>W+</td>
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<tr>
<td>W</td>
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<tr>
<td>E-</td>
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<td>Z</td>
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<td>Dr</td>
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<tr>
<th>Key for Hours</th>
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<td>V</td>
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<td>D</td>
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<td>R</td>
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</table>

ECTS: European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
This course gives an introduction into the fundamentals of semiconductor materials. The main focus is on state-of-the-art fabrication and characterization methods. The course will be continued in the spring term with a focus on applications.

**Objective**

Basic knowledge of semiconductor physics and technology. Application of this knowledge for state-of-the-art semiconductor device processing.

**Content**

- Fundamentals of Solid State Physics: Semiconductor materials, band structures, carrier statistics in intrinsic and doped semiconductors, \( p-n \) junctions, low-dimensional structures;
- Bulk Material growth of Semiconductors: Czochralski method, floating zone method, high pressure synthesis;
- Semiconductor Epitaxy: Fundamentals, MBE, MOCVD, LPE;
- In situ characterization: RHEED, LEED, AES, XPS, process control (temperature, thickness)

**Lecture notes**

https://moodle-app2.let.ethz.ch/course/view.php?id=2295

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0317-00L</td>
<td>Semiconductor Materials: Fundamentals and Fabrication</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>S. Schön. W. Wegscheider</td>
</tr>
</tbody>
</table>

**Abstract**

This course gives an introduction into the fundamentals of semiconductor materials. The main focus is on state-of-the-art fabrication and characterization methods. The course will be continued in the spring term with a focus on applications.

**Course contents**

1) Introduction and reminder of bulk crystals (week 1):
   - Reminder of the crystal structure, x-ray diffraction and determination of the crystal structure.
2) Crystal surfaces (weeks 2 and 3):
   - Definitions, description of surfaces, reconstructions; Moiré patterns; quasi-crystals.
3) Imaging surfaces with electrons (week 4):
   - SEM, LEED, LEEM
4) Imaging surfaces with ions (week 5):
   - LEIS, He-ion microscopy
5) Introduction to probe microscopy (week 6):
   - General problems, field ion microscope, topography
6) Scanning Tunnelling Microscopy (weeks 6, 7 and 8):
   - Tunnelling problem (reminder), work function derivation and measurement with STM, imaging surfaces in real space, surface reconstructions, examples form metals and semiconductors and hybrid surface systems
7) Atomic force microscopy (week 9):
   - Technique, basics, examples.
8) Electronic structure of the bulk (week 10):
   - Reminders: density of states, band structure, low dimensional systems
9) Electronic structure of surfaces (week 11):
   - Bulk derived states, image states, examples from STM research
10) Photoelectric emission (week 12):
    - Basics of spectroscopy with x-rays and electrons.

**Literature**

- Charles Kittel, Introduction to Solid State Physics (8th Ed.)
- Neil W. Ashcroft and N. David Mermin, Solid State Physics
- Harald Ibach and Hans Lüth, Solid-State Physics: An Introduction to Principles of Materials Science
- Further reading material will be supplied.

**Prerequisites / notice**

At least, 4 homework will be assigned.
Semiconductor Nanostructures

A. Imamoglu
A. Vindigni

At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures:

1. The integer quantum Hall effect
2. Conductance quantization in quantum point contacts
3. the Aharonov-Bohm effect
4. Coulomb blockade in quantum dots

Ultrafast Processes in Solids

W  6 credits  2V+1U  Y. M. Acremann, A. Vaterlaus

Abstract
Ultrafast processes in solids are of fundamental interest as well as relevant for modern technological applications. The dynamics of the lattice, the electron gas as well as the spin system of a solid are discussed. The focus is on time resolved experiments which provide insight into pico- and femtosecond dynamics.

Objective
After attending this course you understand the dynamics of essential excitation processes which occur in solids and you have an overview over state of the art experimental techniques used to study fast processes.

Content
1. Experimental techniques, an overview
2. Dynamics of the electron gas
   2.1 First experiments on electron dynamics and lattice heating
   2.2 The finite lifetime of excited states
   2.3 Detection of lifetime effects
   2.4 Dynamical properties of reactions and adsorbents
3. Dynamics of the lattice
   3.1 Phonons
   3.2 Non-thermal melting
4. Dynamics of the spin system
   4.1 Laser induced ultrafast demagnetization
   4.2 Ultrafast spin currents generated by lasers
   4.3 Landau-Lifschitz-Dynamics
   4.4 Laser induced switching
5. Correlated materials

Literature
Relevant publications will be cited.

Prerequisites / notice
The lecture can also be followed by interested non-physics students as basic concepts will be introduced.

This lecture is complementary to the lecture on "ultrafast methods for solid state physics" of the spring semester. Both lectures can be attended independently. The focus of this lecture is on the physical processes whereas the focus of the "ultrafast methods for solid state physics" lecture is on the experimental techniques.

Optical Properties of Semiconductors

W  8 credits  2V+2U  A. Imamoglu, G. Scalari

Abstract
This course presents a comprehensive discussion of optical processes in semiconductors.

Objective
The rich physics of the optical properties of semiconductors, as well as the advanced processing available on these materials, enabled numerous applications (lasers, LEDs and solar cells) as well as the realization of new physical concepts. Systems that will be covered include quantum dots, exciton-polaritons, quantum Hall fluids and graphene-like materials.

Content
Electronic states in III-V materials and quantum structures, optical transitions, excitons and polaritons, novel two dimensional semiconductors, spin-orbit interaction and magneto-optics.

Prerequisites / notice
Prerequisites: Quantum Mechanics I, Introduction to Solid State Physics

Introduction to Magnetism

W  6 credits  2V+1U  A. Vindigni

Abstract
Atomic paramagnetism and diamagnetism, itinerant and local-moment magnetism, Ising and Heisenberg models, the mean-field approximation, spin waves, magnetic phase transition, domains and domain walls, magnetization dynamics from picoseconds to human time scales.

Content
The lecture "Introduction to Magnetism" is the regular course on Magnetism for the Master curriculum of the Department of Physics of ETH Zurich. With respect to specialized courses related to Magnetism (such as the one held by R. Allenspach in FS16) this lecture addresses more fundamental aspects -- quantum and statistical physics of magnetism -- which are often not comprehensively spelled out in conventional lectures on solid state physics.

Preliminary contents for the HS16:
- Magnetism in atoms (quantum-mechanical origin of atomic magnetic moments, intra-atomic exchange interaction)
- Magnetism in solids (mechanisms producing inter-atomic exchange interaction)
- Magnetic order at finite temperatures (Ising and Heisenberg models, mean-field approximation, low-dimensional magnetism)
- Dipolar interaction in ferromagnets (shape anisotropy, frustration and modulated phases of magnetic domains)
- Spin physics in the time domain (Larmor precession, resonance phenomena, Bloch equation, Landau-Lifshitz-Gilbert equation, superparamagnetism)

Lecture notes
Lecture notes and slides are available during the course, through the Moodle portal.

Prerequisites / notice
The former title of this course unit was "Fundamental Aspects of Magnetism". This lecture insists on the fundamental aspects -- quantum physics and statistical physics of magnetism.

Applications to nanoscale magnetism will be considered from the perspective of basic underlying principles.

Semiconductor Nanostructures

W  6 credits  2V+1U  T. M. Ihn

Abstract
The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, field-effect transistors. The physics of the quantum Hall effect and of common nanostructures based on two-dimensional electron gases will be discussed, i.e., quantum point contacts, Aharonov-Bohm rings and quantum dots.

Objective
At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures:

1. The integer quantum Hall effect
2. Conductance quantization in quantum point contacts
3. the Aharonov-Bohm effect
4. Coulomb blockade in quantum dots

Content
1. Introduction and overview
2. Semiconductor crystals: Fabrication and band structures
3. k.p-theory, effective mass
4. Envelope functions and effective mass approximation, heterostructures and band engineering
5. Fabrication of semiconductor nanostructures
6. Electrostatics and quantum mechanics of semiconductor nanostructures
7. Heterostructures and two-dimensional electron gases
8. Drude Transport
9. Electron transport in quantum point contacts; Landauer-Büttiker description
10. Ballistic transport experiments
11. Interference effects in Aharonov-Bohm rings
12. Electron in a magnetic field, Shubnikov-de Haas effect
13. Integer quantum Hall effect
14. Coulomb blockade and quantum dots
In addition to the lecture notes, the following supplementary books can be recommended:

Lecture notes:


Literature:

Modern Topics in Terahertz Science

W 6 credits 2V+1U
S. Johnson

Abstract

This course reviews current research topics in Terahertz Science with a strong focus on scientific applications in physics, chemistry and biology, as well as the emerging field of nonlinear THz optics.

Objective

Terahertz frequency electromagnetic radiation lies at the border between electronics and optics, and as such has many unique properties that make it well-suited to study the electronic, magnetic and structural properties of many materials. The course objective is to give the students the ability to identify problems of current interest in physics, chemistry, materials science and biology that can be potentially addressed using terahertz photonics and to design potential experimental solutions.

Content

Topics to be discussed in the class include:

1) Overview of THz & interactions with matter
2) THz generation and detection
3) Linear THz spectroscopies
4) Imaging
5) Nonlinear THz interactions

Lecture notes

Scripts will be distributed via moodle.

Literature

The readings for the course will draw mostly on current journal articles that will be distributed in class/via moodle. There is also a general textbook listed below available electronically via the ETH library system. You can also order a black-and-white paperback via an "on-demand" system for a pretty reasonable price.

Prerequisites / notice

The course is suitable for all physics students beyond the bachelor of science degree. Basic knowledge of solid state physics is recommended. Very ambitious students in the third year may be able to follow. The lecture can be chosen as part of the PhD-program. The course is taught in English.

402-0415-62L

Modern Topics in Terahertz Science

W 6 credits 2V+1U
S. Johnson

402-0715-00L

Low Energy Particle Physics

W 6 credits 2V+1U
A. S. Antognini, P. A. Schmidt-Wellenburg

402-0767-00L

Neutrino Physics

W 6 credits 2V+1U
A. Rubbia

The former course title of this course is "Terahertz Technology and Applications".

402-0715-00L

Low Energy Particle Physics

W 6 credits 2V+1U
A. S. Antognini, P. A. Schmidt-Wellenburg

Abstract

Low energy particle physics provides complementary information to high energy physics with colliders. In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today.

Objective

The course aims to provide an introduction to selected advanced topics in low energy particle physics with neutrons and muons.

Content

Low energy particle physics provides complementary information to high energy physics with colliders. At the Large Hadron Collider one directly searches for new particles at energies up to the TeV range. In a complementary way, low energy particle physics indirectly probes the existence of such particles and provides constraints for "new physics", making use of precision and high intensities.

Besides the sensitivity to effects related with new physics (e.g. lepton flavor violation, symmetry violations, CPT tests, search for electric dipole moments, new low mass exchange bosons etc.), low energy physics provides the best test of QED (electron g-2), the best tests of bound-state QED (atomic physics and exotic atoms), precise determinations of fundamental constants, information about the CKM matrix, precise information on the weak and strong force even in the non-perturbative regime etc.

In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today. Starting from a general introduction on high intensity/high precision particle physics and the main characteristics of muons and neutrons and their production, we will then focus on the discussion of fundamental problems and ground-breaking experiments:

- Production and characteristics of muon and neutron beams
- Ultracold neutron production
- Measurement of the neutron lifetime and electric dipole moment
- The neutron in the gravitational field and its electric charge
- Muon and neutron decay correlations
- Lepton flavour violations with muons to search for new physics
- What atomic physics can do for particle physics and vice versa
- Laser experiments at accelerators
- From myonic hydrogen to the proton structure and bound state QED
- From piconic hydrogen to the strong interaction and effective field theories
- etc.

Literature

Golub, Richardson & Lamoreaux: "Ultra-Cold Neutrons"
Rauch & Werner: "Neutron Interferometry"
Carlile & Willis: "Experimental Neutron Scattering"
Byrne: "Neutrons, Nuclei and Matter"
Klapdor-Kleingrothaus: "Non Accelerator Particle Physics"

Prerequisites / notice

Einführung in die Kern- und Teilchenphysik / Introduction to Nuclear- and Particle-Physics.

402-0767-00L

Neutrino Physics

W 6 credits 2V+1U
A. Rubbia

Abstract

Theoretical basis and selected experiments to determine the properties of neutrinos and their interactions (mass, spin, helicity, chirality, oscillations, interactions with leptons and quarks).

Objective

Introduction to the physics of neutrinos with special consideration of phenomena connected with neutrino masses.

Lecture notes

Script
Literature


D.O. Caldwell, Current Aspects of Neutrino Physics, Springer.


402-0883-63L Symmetries in Physics W 6 credits 2V+1U M. Gaberdiel

Abstract

The course gives an introduction to symmetry groups in physics. It explains the relevant mathematical background (finite groups, Lie groups and algebras as well as their representations), and illustrates their important role in modern physics.

Objective

The aim of the course is to give a self-contained introduction into finite group theory as well as Lie theory from a physicists point of view. Abstract mathematical constructions will be illustrated with examples from physics.

402-0899-00L The Physics of Electroweak Symmetry Breaking W 6 credits 2V+1U not available

Abstract

The aim is to understand the need of physics beyond the Standard Model, the basic techniques of model building in theories BSM and the elements of collider physics required to analyze their phenomenological implications. After an introduction to the SM and alternative theories of electroweak symmetry breaking, we will investigate these issues in the context of models with warped extra dimensions.

Objective

After the course the student should have a good knowledge of some of the most relevant theories beyond the Standard Model and have the techniques to understand those theories that have not been surveyed in the course. He or she should be able to compute the constraints on any model of new physics, its successes explaining current experimental data and its main phenomenological implications at colliders.

Prerequisites / notice

The former title of this course unit was "The Physics Beyond the Standard Model". If you already got credits for "The Physics Beyond the Standard Model" (402-0898-00L), you cannot get credits for "The Physics of Electroweak Symmetry Breaking" (402-0899-00L).

402-0845-60L Quantum Field Theory III: EFT and SUSY W 6 credits 2V+1U G. Isidori

Abstract

This course provides a comprehensive introduction to two advanced topics in Quantum Field Theory: Effective Field Theories (EFTs) and Supersymmetry (SUSY).

Content

In the first part we will discuss the basic concepts of EFTs, with particular attention to the concepts of decoupling of heavy degrees of freedom, matching and renormalization, chiral Lagrangians. The Standard Model viewed as an EFT will also be discussed as a specific application. The second part of the course is devoted to Supersymmetry, starting from the discussion of the SUSY algebra and its representations, to arrive, after the presentation of the superfield formalism, to the construction of the supersymmetric version of gauge field theories. A phenomenological discussion of the mechanisms of SUSY breaking and the construction of viable supersymmetric extensions of the Standard Model will also be presented.

Topics:

- Introduction to Effective Field Theories
- The Appelquist-Carrazone theorem
- The matching procedure
- Chiral Lagrangians
- The SM as an EFTs
- The SUSY algebra
- Superspace and superfields
- Supersymmetric field theories
- Supersymmetric gauge theories
- Supersymmetry breaking
- The Minimal supersymmetric Standard Model

Literature

J. Wess and J. Bagger, "Supersymmetry and supergravity".
Mueller-Kirsten & Wiedemann, "Introduction to supersymmetry".

Prerequisites / notice

QFT-I (mandatory) and QFT-II (highly recommended).

402-0899-65L Higgs Physics W 6 credits 2V+1U M. Grazzini

Abstract

The course introduces the theory and phenomenology of the recently discovered Higgs boson. With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

Objective

With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 470 of 1571
The goal of this course is to understand some of the phenomena that stand in the forefront of current research in astrophysics, the physical processes behind them, and how these phenomena are observed by state-of-the-art astronomical facilities. These goals will be achieved by communal discussions, led by the students and chaired by the teachers.

### Prerequisites

- Knowledge of advanced research in the area of energy.
- M. Mazzotti, R. S. Abhari, A. Amara

### Content

- Statistical principles and tools that are used in these fields. Topics covered will include basic probability theory, Bayesian inference, hypothesis testing, sampling and estimators.
- Development of basic probability and statistical theory. Gain practical knowledge of statistical methods commonly used in cosmology and astrophysics.

### Objective

- Develop an understanding of basic research in the area of energy.

### Literature

- Higgs Hunter's Guide (by S.Dawson, J. Gunion, H. Haber and G. Kane)

### Prerequisites / notice

### 402-0381-64L

**Hot Topics in Astrophysics**

<table>
<thead>
<tr>
<th>W</th>
<th>4 credits</th>
<th>2V</th>
<th>M. Carollo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The themes we will discuss this year are:</td>
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<tr>
<td><em>(1)</em> How do baryons and dark matter interact?</td>
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<tr>
<td><em>(2)</em> Where, and in what state, do baryons reside within dark matter halos?</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to understand some of the phenomena that stand in the forefront of current research in astrophysics, the physical processes behind them, and how these phenomena are observed by state-of-the-art astronomical facilities. These goals will be achieved by communal discussions, led by the students and chaired by the teachers.</td>
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<tr>
<td>Content</td>
<td>Major topics include:</td>
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<tr>
<td>How to set up your computing environment, data management, catalog generation and the Virtual Observatory, collaborative tools</td>
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<tr>
<td>-Optical imaging and spectroscopy:</td>
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<tr>
<td>Basics of observatories (ground vs space), multi-wavelength data, detector types, reduction and analysis strategies for imaging and spectroscopic data, types of spectographs, interpreting spectra including stellar and galaxy evolution models</td>
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<tr>
<td>-X-ray, IR and radio astronomy:</td>
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<tr>
<td>Basics of X-ray and high energy detectors and telescopes, spectral fitting, basics of radio astronomy, interferometric observations, aperture synthesis, source confusion and decomposition</td>
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<tr>
<td>-Planning of observations and proposal writing:</td>
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<tr>
<td>-Analysis of real-world data:</td>
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<tr>
<td>Various examples from across the spectrum (ground and space-based)</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Astrophysics I is required and Astrophysics II is recommended. Some programming skills in Python or similar languages are necessary.</td>
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</table>

### 402-0353-63L

**Observational Techniques in Astrophysics**

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>2V+1U</th>
<th>K. Schawinski</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The course introduces analysis techniques, the basics of astronomical instruments, real-world observational tools, data reduction strategy and software packages used in astrophysics research. The course will also include discussions of current topics in astrophysics with a focus on active galaxies. The course will include the reduction and analysis of real data from a variety of observatories.</td>
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<tr>
<td>Objective</td>
<td>The goal is to acquaint students with the basics of a range of astrophysical observation techniques including the modern software tools needed to analyze data.</td>
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<tr>
<td>Content</td>
<td>Major topics include:</td>
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<tr>
<td>-Scientific programming and analysis tools</td>
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<tr>
<td>-Optical imaging and spectroscopy:</td>
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<tr>
<td>Basics of observatories (ground vs space), multi-wavelength data, detector types, reduction and analysis strategies for imaging and spectroscopic data, types of spectographs, interpreting spectra including stellar and galaxy evolution models</td>
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<tr>
<td>-X-ray, IR and radio astronomy:</td>
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<tr>
<td>Basics of X-ray and high energy detectors and telescopes, spectral fitting, basics of radio astronomy, interferometric observations, aperture synthesis, source confusion and decomposition</td>
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<tr>
<td>-Analysis of real-world data:</td>
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<tr>
<td>Various examples from across the spectrum (ground and space-based)</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Astrophysics I is required and Astrophysics II is recommended. Some programming skills in Python or similar languages are necessary.</td>
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### 402-0375-63L

**Statistical Methods in Cosmology and Astrophysics**

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>2V+1U</th>
<th>A. Amara</th>
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</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Statistical methods play a vital role in modern cosmology and astrophysics studies. This course will give an overview of the statistical principles and tools that are used in these fields. Topics covered will include basic probability theory, Bayesian inference, hypothesis testing, sampling and estimators.</td>
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<tr>
<td>Objective</td>
<td>Develop an understanding of basic research in the area of energy.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Credit or current enrollment in Astrophysics I is recommended but not required</td>
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</tbody>
</table>

### 151-0906-00L

**Frontiers in Energy Research**

<table>
<thead>
<tr>
<th>W</th>
<th>2 credits</th>
<th>2S</th>
<th>M. Mazzotti, R. S. Abhari, J. Carmeliet, M. Filippini</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course is only for doctoral students.</td>
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<tr>
<td>Objective</td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.</td>
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<tr>
<td>Content</td>
<td>Knowledge of advanced research in the area of energy. Every week there are two presentations, each structured as follows: 15 min introduction to the research topic, 15 min presentation of the results, 15 min discussion with the audience.</td>
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<tr>
<td>Lecture notes</td>
<td>Slides will be distributed.</td>
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### 529-0477-00L

**Molecular Quantum Dynamics**

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<thead>
<tr>
<th>W</th>
<th>0 credits</th>
<th>1V</th>
<th>R. Marquardt</th>
</tr>
</thead>
</table>
This lecture covers advanced topics in ultra-fast time resolved molecular spectroscopy and kinetics. Although primarily theoretical, and focused on quantum phenomena, contents include the discussion of certain modern experimental techniques.

**Goals:**
- Acquisition of the basic knowledge in modern, ultra-fast Spectroscopy and chemical kinetics and of some knowledge of theoretical methods currently used to interpret experimental data; exercise the interpretation of computational results related to molecular quantum dynamics on selected examples and discussion of the problems involved.
- The lecture is intended to be a brief introduction to essential aspects regarding quantum dynamics, in particular regarding molecular physics and the primary steps of chemical reactions. It proposes also an introduction to the methods and computational algorithms used in the theoretical treatment of molecular quantum dynamics, in particular of short time propagation of wave packets. A practical course in handling computer programs specifically devised for quantum dynamics is offered.

**Lecture notes / Literature**
A program and handouts can be downloaded from the indicated web site or will be delivered in the first session. Handouts are in English.


**Prerequisites / notice**
A solid knowledge in quantum mechanics is helpful, but not a condition to assist the lecture.
## Doctoral Department of Physics - Key for Type

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<tr>
<th>Code</th>
<th>Description</th>
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</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<td>O</td>
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## Key for Hours

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<td>lecture</td>
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<td>G</td>
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<td>exercise</td>
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<td>colloquium</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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## ECTS

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Special students and auditors need special permission from the lecturers.
Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.

Students will be able to understand and evaluate experimental design and data interpretation of on-going studies, be able to critically analyze published research results, practice to present and discuss results in the public, and gain a broad knowledge of recent research and current topics in agro- and forest ecosystem sciences.

Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.

Prerequisites: Basic knowledge of plant ecophysiology, terrestrial ecology and management of agro- and forest ecosystems. Course will be taught in English.

Number of participants limited to 18.

This course is about the physical, chemical, and biological processes in the rhizosphere and their effect on plant growth. Effects of fertilisers, companion plants, and microbial symbionts, and other microbes on nutrient cycling and plant uptake are discussed. An "intercropping" experiment in the glasshouse is used as a model to check for rhizosphere effects on plant growth and mineral nutrition.

Develop skills on the critical analysis of scientific papers, define explanatory hypotheses, identify knowledge gaps for further investigations.

Carry out a multi-disciplinary experiment that involves aspects of soil, (micro-)biology, plant physiology, pathology, and ecology. Develop manual skills in the set up of a glasshouse experiment, in soil and plant analyses, and in isolation and DNA-based characterisation of rhizobia.

Gain insights on basic methods to analyse (bio-)chemical, molecular genetic, and graphical data. Discuss and interpret data in the context of the literature.

Prepare a research report in the format of a scientific paper and a poster in the format of a conference paper, partially alone and partially in small groups, using data obtained from the glasshouse experiment.

This course is designed to stimulate thinking and promote critical analysis of important processes that occur in the rhizosphere. As part of this course, the knowledge acquired will be used for analysing and interpreting experimental data, as well as, preparing a scientific report and conference-type poster.

The course will cover the relative importance of spatial scales and various physicochemical and microbiological dynamics as influenced by roots. We will discuss root traits and activities that influence the immediately root-surrounding soil and thereby contribute to mineral nutrient mobilization and immobilization. An overview of the most relevant root-microbe symbioses for agroecosystems will be provided and root and microbial traits discussed, which could be of use in efforts towards utilization of intercropping and bioinoculants as a possible means of reducing energetically expensive inputs to farming systems. A special emphasis will be given to the importance of physicochemical features of soils and the chemical forms (= species) of elements important for plant uptake.

Practical experience will be gained with setting up a glasshouse experiment, soil and root sampling, basic soil and plant analyses, isolation of rhizobia, determination of the number of colony forming units (CFU), assays to screen for phosphorus and zinc solubilizing bacteria, DNA extraction, PCR amplification, and restriction fragment length polymorphism analysis (RFLP) of host range determining symbiosis-specific genes.

In short, the processes dealt with in this course occur on a small-scale and are generally (bio)chemical and microbiological in nature. Furthermore, they are generally not taken into account using current methods of agronomic management for plant production. However, they are increasingly being recognized as a potentially useful means of obtaining a resource-efficient and hence, economically and environmentally sustainable agricultural system, including for ecosystem restoration. Therefore, the course will invite for critical reflections and exemplify challenges in translating knowledge from scientific studies and ecology into application for plant production.

For documentation, lecture slides and laboratory protocols will continuously be uploaded to the directory '751-5123-00L Rhizosphere Ecology' on the electronic document exchange platform ILIAS, LDA-ELBA: https://ilias-app2.let.ethz.ch/ilias.php?ref_id=109651&cmd=view&cmdClass=ilobjcoursegui&cmdNode=el:fv&baseClass=ilRepositoryGUI
Autumn Semester 2016

551-0205-00L

Challenges in Plant Sciences

Number of participants limited to 40.

W 2 credits 2K

W. Gruissem, C. Sánchez-Rodríguez, further lecturers

Abstract

The colloquium introduces students to the disciplines in plant sciences and provides integrated knowledge from the molecular level to ecosystems and from basic research to applications, making use of the synergies between the different research groups of the PSC. The colloquium offers a unique chance to approach interdisciplinary topics as a challenge in the field of plant sciences.

Objective

Major objectives of the colloquium are:

- introduction of graduate students and Master students to the broad field of plant sciences
- promotion of an interdisciplinary and integrative teaching program
- promotion of active participation and independent work of students
- promotion of presentation and discussion skills
- increased interaction among students and professors

Prerequisites / notice

We ask all course attendees of the agricultural sciences to have passed the exams at the end of the lectures Plant Nutrition I and II (Nutrient cycling in agroecosystems) by Prof. E. Frossard. All others, have to have successfully worked through the e-learning module Plant Nutrition I by Prof. E. Frossard. All others, have to have successfully worked through the e-learning module Plant Nutrition I by Prof. E. Frossard: https://moodle-app2.let.ethz.ch/course/view.php?id=279

Remark: The course is designed to be complementary to those on Radiosotopes in Plant Nutrition (751-3405-00L), and Nutrient Fluxes in Soil-Plant Systems (751-3404-00L), although some thematic overlaps cannot be avoided. Special emphasis is given to plant-microbe-soil interactions and an appreciation of whole plant functioning in the ecological context. You will familiarize yourself with bacterial isolation, cultivation, enumeration, as well as, molecular detection, discrimination and identification techniques for rhizosphere and root-associated microbes. Marking will consider the efforts and outcome of work by the individual participant as well as results of work in small groups. Activities for the course will result in posters and reports in the format of a conference and scientific paper. Reports will be due on Friday January 6, 2017.

Maximum number of participants: 18 (Attention: Admission will be on a first come first served basis - inscribe early!). Students of D-USYS will be reimbursed via bank transfer for train and bus tickets of the zones 121 and 122 (Please send all tickets with the bank details to Christiane Gujan (http://www.plantnutrition.ethz.ch/the-group/people-a-z/person-detail.html?persid=85593).

Soil-Plant Systems (751-3404-00L), although some thematic overlaps cannot be avoided. Special emphasis is given to plant-microbe-soil interactions and an appreciation of whole plant functioning in the ecological context. You will familiarize yourself with bacterial isolation, cultivation, enumeration, as well as, molecular detection, discrimination and identification techniques for rhizosphere and root-associated microbes. Marking will consider the efforts and outcome of work by the individual participant as well as results of work in small groups. Activities for the course will result in posters and reports in the format of a conference and scientific paper. Reports will be due on Friday January 6, 2017.

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### Environmental Sciences

#### Atmosphere and Climate

<table>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>402-0572-00L</td>
<td>Aerosols I: Physical and Chemical Principles</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>M. Gysel, U. Baltensperger, H. Burtscher</td>
</tr>
</tbody>
</table>

**Abstract**

Aerosols I deals with basic physical and chemical properties of aerosol particles. The importance of aerosols in the atmosphere and in other fields is discussed.

**Objective**

Knowledge of basic physical and chemical properties of aerosol particles and their importance in the atmosphere and in other fields is discussed.

**Content**

- Physical and chemical properties of aerosols, aerosol dynamics (diffusion, coagulation...), optical properties (light scattering, absorption, extinction), aerosol production, physical and chemical characterization.

**Literature**


**Lecture notes**

Materiel is distributed during the lecture.

**Prerequisites / notice**


#### Analysis of Climate and Weather Data

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<tr>
<th>Number</th>
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<tr>
<td>701-1250-00L</td>
<td>Analysis of Climate and Weather Data</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>C. Frei</td>
</tr>
</tbody>
</table>

**Abstract**

Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

**Objective**

Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

**Content**

- Introduction into the theoretical background and the practical application of methods of data analysis in meteorology and climatology.

**Topics:** exploratory methods, hypothesis tests, analysis of climate trends, measuring the skill of climate and forecasting models, analysis of extreme events, principal component analysis and maximum covariance analysis.

**The lecture also provides an introduction into R, a programming language and graphics tool frequently used for data analysis in meteorology and climatology. During hands-on computer exercises the student will become familiar with the practical application of the methods.**

**Literature**

- All material is made available via the lecture web-page.

**Suggested literature:**


**Prerequisites / notice**

- Prerequisites: Atmosphäre, Mathematik IV: Statistik, Anwendungsnahes Programmieren.

#### Cloud Microphysics

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<tr>
<th>Number</th>
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<tr>
<td>701-1235-00L</td>
<td>Cloud Microphysics</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>U. Lohmann, Z. A. Kanji</td>
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</table>

**Abstract**

Clouds are a fascinating atmospheric phenomenon central to the hydrological cycle and the Earth’s climate. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes.

**Objective**

The learning objective of this course is that students understand the formation of clouds and precipitation and can apply learned principles to interpret atmospheric observations of clouds and precipitation.

**Content**

See: http://www.iac.ethz.ch/edu/courses/master/modules/cloud-microphysics.html

**Lecture notes**

This course will be designed as a reading course in 1-2 small groups of 8 students maximum. It will be based on the textbook below. The students are expected to read chapters of this textbook prior to the class so that open issues, fascinating and/or difficult aspects can be discussed in depth.

**Literature**


**Prerequisites / notice**

- Target group: Master students in Atmosphere and Climate

#### Dynamics of Large-Scale Atmospheric Flow

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<tr>
<th>Number</th>
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<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
</tbody>
</table>

**Abstract**

Dynamic, synoptic Meteorology

**Objective**

Understanding the dynamics of large-scale atmospheric flow

**Content**

Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

**Lecture notes**

Dynamics of large-scale atmospheric flow
### Literature
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

### Prerequisites / notice
- Physics I, II, Environmental Fluid Dynamics

<table>
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<tr>
<td>701-1251-00L</td>
<td>Land-Climate Dynamics</td>
<td>3</td>
<td>W</td>
<td>S. I. Seneviratne, E. L. Davin</td>
</tr>
</tbody>
</table>

#### Objective
The students can understand the role of land processes and associated feedbacks for the climate system.

#### Lecture notes
Powerpoint slides will be made available

### Prerequisites / notice
Prerequisites: Introductory lectures in atmospheric and climate science
- Atmospheric physics -> [link](http://www vvz ethz ch/Vorlesungsverzeichnis/lerneinheitPre do?lerneinheitId=61924&semkez=2009W&lang=en)
- Climate systems -> [link](http://www vvz ethz ch/Vorlesungsverzeichnis/lerneinheitPre do?lerneinheitId=57794&semkez=2009S&lang=en)

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<td>701-1237-00L</td>
<td>Solar Ultraviolet Radiation</td>
<td>1</td>
<td>W</td>
<td>J. Gröbner</td>
</tr>
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</table>

#### Abstract
The lecture will introduce the student to the thematics of solar ultraviolet radiation and its effects on the atmosphere and the biosphere. The lecture will cover the modeling and the measurement of solar ultraviolet radiation. The instruments used for solar radiation measurements will also be introduced.

#### Objective
The lecture should enable the student to understand the specific problematics related to solar ultraviolet radiation and its interaction with the atmosphere and the biosphere.
1) Einführung in die Problematik  Motivation
Begriffe (UV-C, UV-B, UV-A,...)
Einfluss der UV Strahlung auf Biosphäre (Mensch, Tier, Pflanzen)
Positive und schädliche Effekte
Wirkungsspektrum, Konzept, Beispiele
UVIndex:

2) Geschichtlicher Rückblick
Rayleigh - Himmelsblau
1907: Dorno, PMOD
1970: Bener, PMOD
1980: Berger, Erythemal sunburn meter
1990: State of the Art

3) Extraterrestrische UV Strahlung
Spektrum
Energieverteilung
Variabilität (Spectral, zeitlich, relativ zu Totalstrahlung)
Satellitenmessungen, Übersicht

4) Einfluss der Atmosphäre auf die solare UV Strahlung
Atmosphärenaufbau
Beinflussende Parameter (Ozon, Wolken, ...)
Ozon, Stratosphärisches versus troposphärisches
Geschichte: Ozondepletion, Pole Ozonlöcher und Einfluss auf die UV Strahlung
Wolken
Aerosole
Rayleighstreuung
Trends (Ozon, Wolken, Aerosole)
Radiation Amplification Factor (RAF)

5-6) Strahlungstransfer
Strahlungstransfergleichung
Modellierung, DISORT
libRadtran, TUV, FASTRT
Parameter
Sensitivitätsstudien
Vergleiche mit Messungen
3-D Modellierung (MYSTIC)
Beer-Lambert Gesetz

7) Strahlungsmessungen
Instrumente zur Strahlungsmessung
Messgrößen: Irradiance (global, direct, diffus), radiance, aktinischer Fluss
Horizontale und geneigte Flächen
Generelle Problematik: Freiluftmessungen...
Qualitätssicherung

8) Solare UV Strahlungsmessungen
Problematic: Dynamik, Spektrale Variabilität, Alterung
Stabilität
Spezifische Instrumente: Filterradiometer, Spektroradiometer, Dosimetrie
Übersicht Aufbau und Verwendung

9-10) Solare UV Strahlungsmessgeräte
Spektroradiometer, Filterradiometer (Breit und schmalbandig)
Charakterisierung
Kalibriermethoden (Im Labor, im Feld)
Qualitätssicherung, Messkampagnen

11-12) Auswerteverfahren
Atmosphärische Parameter aus Strahlungsmessungen
Ozon, SO2
Albedo (Effektiv versus Lokal)
Aerosol Parameter (AOD, SSA, g, Teilchenverteilungen)
Zusammenspiel Messungen - Modellierung
Aktinische UV-Strahlungsflüsse und Bestimmung von atmosphärischen Photolysefrequenzen

13) UV Klimatologie
Trends
UV Klimatologie durch Messnetze
UV Klimatologie durch Satellitenmessungen am Beispiel von TOMS
Modellierung am Beispiel Meteosat-JRC
UV Rekonstruktionen

14) Aktuelle Forschungen
Internationale Projekte, Stand der Forschung

---

**Abstract**
Thermodynamical and kinetic basics: bi- and termolecular reactions, photo-dissociation. Chemical family concept. Chapman chemistry. Radical reactions of oxygen species with nitric oxide, active halogens and odd hydrogen. Ozone depletion cycles. Methane depletion and ozone production in the lower stratosphere. Heterogeneous chemistry on background aerosol. Chemistry and dynamics of the ozone hole. The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect.

**Objective**
In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other's work.

Training scientific writing skills.

In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other's work.

Attendence is mandatory.

The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

### Biogeochemistry and Pollutant Dynamics

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>701-1314-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.</td>
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<tr>
<td>Objective</td>
<td>The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.</td>
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<tr>
<td>Content</td>
<td>The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.</td>
<td></td>
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<tr>
<td>Lecture notes</td>
<td>Handouts will be distributed</td>
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| 701-1315-00L| Isotopic and Organic Tracers in Biogeochemistry | W    | 3    | 2G    | R. Kipfer, S. Ladd                                                      |
| Abstract    | The course introduces the scientific concepts and typical applications of tracers in biogeochemistry. The course covers stable and radioactive isotopes, geochemical tracers and biomarkers and their application in biogeochemical processes as well as regional and global cycles. The course provides essential theoretical background for the lab course “Isotopic and Organic Tracers Laboratory”. |      |      |                   |                                                                 |
| Objective   | The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radiogenic isotopes. They discover the spectrum of possible geochemical tracers and biomarkers, their potential and limitations and get familiar with important applications |      |      |                   |                                                                 |
| Content     | Geoenic and cosmogenic radionuclides (sources, decay chains); stable isotopes in biogeochemistry (natural abundance, fractionation); geochemical tracers for processes such as erosion, productivity, redox fronts; biomarkers for specific microbial processes. |      |      |                   |                                                                 |
| Lecture notes | Handouts will be provided for every chapter |      |      |                   |                                                                 |
| Literature  | A list of relevant books and papers will be provided |      |      |                   |                                                                 |
| Prerequisites / notice | Students should have a basic knowledge of biogeochemical processes (BSc course on Biogeochemical processes in aquatic systems or equivalent). |      |      |                   |                                                                 |

| 701-1315-00L| Biogeochemistry of Trace Elements | W    | 3    | 2G    | A. Voegelin, M. Etique, L. Winkel                                         |
| Abstract    | The course addresses the biogeochemical classification and behavior of trace elements, including key processes driving the cycling of important trace elements in aquatic and terrestrial environments and the coupling of abiotic and biotic transformation processes of trace elements. Examples of the role of trace elements in natural or engineered systems will be presented and discussed in the course. |      |      |                   |                                                                 |
| Objective   | The students are familiar with the chemical characteristics, the environmental behavior and fate, and the biogeochemical reactivity of different groups of trace elements. They are able to apply their knowledge on the interaction of trace elements with geosphere components and on abiotic and biotic transformation processes of trace elements to discuss and evaluate the behavior and impact of trace elements in aquatic and terrestrial systems. |      |      |                   |                                                                 |
Lecturers

It is our aim that participants gain insight into the current research topics and knowledge available in Ecological Genetics and learn to

From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the

F. Knaus

After an introduction (one afternoon), students will have 3 weeks to work independently or in groups through different protocols. At the end

Papers will be assigned and downloaded from a web page announced during the lecture.

A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence,

W

N. Gruber

To learn and improve on standard and modern methods of genetic data collection. Examples are: use of pyrosequencing, expression

D. Croll

This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific

A. M. Minder Pfyl

The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census

U. Bollens Hunziker

None

Will be identified based on the chosen topic.

Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.

ECTS

Number of participants limited to 8.

Students are expected to be familiar with the basic concepts of aquatic and soil chemistry covered in the respective classes at the bachelor

Students are expected to be familiar with the basic concepts of aquatic and soil chemistry covered in the respective classes at the bachelor

Type

Objective

701-1346-00L

Carbon Mitigation

W

3 credits

2G

N. Gruber

The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their

Potential, their cost, and their consequences.

From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the

None

Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

Students are expected to be familiar with the basic concepts of aquatic and soil chemistry covered in the respective classes at the bachelor

Genetic Diversity: Techniques

W

2 credits

2P

A. M. Minder Pfyl

(i) Definition, importance and biogeochemical classification of trace elements. (ii) Key biogeochemical processes controlling the cycling of

Different trace elements (base metals, redox-sensitive and chalcophile elements, volatile trace elements) in natural and engineered

Environments. (iii) Abiotic and biotic processes that determine the environmental fate and impact of selected trace elements.

Number of participants limited to 8.

Selection of the students: order of registration

Registration until 17.10.2016.

This course provides training for advanced students (master, doctoral or post-doctoral level) in how to measure and collect genetic diversity

Data from populations, experiments, field and laboratory. Different DNA/RNA extraction, genotyping and gene expression techniques will be

Choice of topic by demand and/or availability of data.

To learn and improve on standard and modern methods of genetic data collection. Examples are: use of pyrosequencing, expression

A course for practicioners.

After an introduction (one afternoon), students will have 3 weeks to work independently or in groups through different protocols. At the end

Techniques addressed are: RNA/DNA extractions and quality control, SNP genotyping, pyrosequencing, real-time qPCR.
Experimental Ecology: Evolution and Ecology

**Lecture notes**
Material will be handed out in the course.

**Prerequisites / notice**
Two afternoons are held in the class. The lab work will be done from the students according to their timetable, but has to be finished after 3 weeks. Effort is roughly 1-2 days per week, depending on the skills of the student.

**Course Code**: 701-1676-01L
**Module Type**: W
**ECTS**: 3G

**Lecture notes**
Material will be handed out in the course.

**Themes**
Getting familiar with scientific arguments and discussions. Overview of current research topics. Making contacts with fellow students in 3G

**Objective**
This six-day winter school aims at teaching advanced Master students, PhD students and postdocs on landscape genetics. It provides both theoretical background as well as hands-on exercises on major topics of contemporary landscape genetics and landscape genomics such as landscape effects on gene flow and adaptive genetic variation in a landscape context.

**Content**
Landscape genetics is an evolving scientific field of both basic and applied interest. Researchers as well as conservation managers make increasing use of landscape genetic thinking and methods. Landscape genetics builds on concepts and methods from landscape ecology and population genetics. This winter school introduces advanced students to major concepts and methods of landscape genetics and genomics, i.e. (i) the study of landscape effects on dispersal and gene flow and (ii) the study of the interactions between the environment and adaptive genetic variation. The winter school focuses on currently used methods and hands-on exercises. It is specifically aimed at the needs of advanced students (Master, PhD and postdocs).

**Prerequisites**
Good knowledge in population genetics and experience in using GIS is required.

**Literature**
Hand-outs will be distributed.

**Prerequisites / notice**
The course requires 4 hours of preparatory reading of selected papers on landscape genetics. These papers will be distributed by e-mail.

**Grading**
Grading will be according to a short written report (4 pages) on one of the themes of the course (workload: about 8 hours) and according to student contributions during the course.

**Prerequisites**
Students should have basic knowledge in population genetics, GIS and R.

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**Course Code**: 551-0737-00L
**Module Type**: W
**ECTS**: 2S

**Abstract**
Interaction seminar. Student-mediated presentations, guests and discussions on current themes in ecology, evolutionary and population biology.

**Objective**
Getting familiar with scientific arguments and discussions. Overview of current research topics. Making contacts with fellow students in other groups.

**Content**
Scientific talks and discussions on changing subjects.

**Literature**
None

**Grading**
For information and details: http://www.eco.ethz.ch/news/zis or contact: Lehre-eve@env.ethz.ch

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**Course Code**: 701-1651-00L
**Module Type**: W
**ECTS**: 3G

**Lecture notes**
Lecture slides and additional course material will be provided throughout the semester.

**Literature**
None

**Prerequisites / notice**
Number of participants limited to 14.

**Abstract**
The course addresses environmental policies, focusing on new steering approaches, which are generally summarized as environmental governance. The course also provides students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

**Objective**
To understand how an environmental problem may (not) become a policy and explain political processes, using basic concepts and techniques from political science.

**Content**
To analyze the evolution as well as the key elements of environmental governance.

To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

**Literature**
We will mostly work with readings from the following books:

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Data: 06.11.2018 12:57
Autumn Semester 2016
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We recommend that students have (a) three-years BSc education of a (technical) university; (b) successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

851-0589-00L  Technology and Innovation for Development  W  3 credits  2V  P. Aerni

Abstract
Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects.

Objective
- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology
- improved understanding of the role of science and technology in the context of human and societal development

Content
Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies. The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

Lecture notes
Reader with issue-specific articles. E-version is partly available under https://www.ethz.ch/content/specialinterest/gess/cis/international-relations/en/teaching/materials/tech.html
Prerequisites / notice

The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester.

Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on an article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

701-1543-00L Transdisciplinary Methods and Applications W 3 credits 2G P. Krütli, M. Stauffacher

The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines.

Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

Abstract

The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines.

Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.
Objective

At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2017

Content

The lecture is structured as follows:

- Overview of concepts and methods of inter-transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

Lecture notes

Handouts are provided by the lecturers

Literature

Selected scientific articles and book-chapters

Prerequisites / notice

This course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.

701-1551-00L Sustainability Assessment  W  3 credits  2G  P. Krütli, C. E. Pohl

Abstract

The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

The course is seminar-like, interactive.

Objective

At the end of the course students should:

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content

The course is structured as follows:

- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Trade-offs in selected examples.

Lecture notes

Handouts.

Literature

Selected scientific articles & book chapters

Forest and Landscape Management

Number  Title  Type  ECTS  Hours  Lecturers

701-1615-00L Advanced Forest Pathology  W  3 credits  2G  T. N. Sieber

Abstract

In-depth understanding of concepts, insight into current research and experience with methods of Forest Pathology based on selected pathosystems.

Objective

To know current biological and ecological research on selected diseases, to be able to comment on it and to understand the methods.
To understand the dynamics of selected pathosystems and disturbance processes.
To be able to diagnose tree diseases and injuries.
To know forest protection strategies and to be able to comment on them.

Content

Stress and disease, virulence and resistance, disease diagnosis and damage assessment, tree disease epidemiology, disease management, ecosystem pathology.
Systems (examples): Air pollution and trees, endophytic fungi, mycorrhiza, wood decay, conifer- root rot, Phytophthora diseases, chestnut canker and its hypoviruses, urban trees, complex diseases, emerging diseases

Lecture notes

no script, the ppt-presentations and specific articles will be made available among others:

Prerequisites / notice

The course is composed of introductory lectures, practical work, discussions and reading. The participants should have basic knowledge in forest pathology (corresponding to the course 701-0563-00 *Wald- und Baumkrankheiten, see teaching book of H. Butin: Tree diseases and disorders, Oxford University Press 1995, 252 pp.).

701-1631-00L Foundations of Ecosystem Management  W  5 credits  3G  J. Ghazoul, C. Garcia

Abstract

This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

Objective

Students should be able to
a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.
b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.
To understand how an environmental problem may (not) become a policy and explain political processes, using basic concepts and techniques from political science.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are the key elements of ‘environmental governance’ and how legitimate and effective are these approaches in addressing persistent environmental challenges?

To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

We recommend that students have (a) three-years BSc education of a (technical) university; (b) successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik oder equivalent)) and (c) familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

Lecture slides and additional course material will be provided throughout the semester.

We will mostly work with readings from the following books:

A detailed course schedule will be made available at the beginning of the semester.

We recommend that students have (a) three-years BSc education of a (technical) university; (b) successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik or equivalent) and (c) familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

Sampling techniques for forest inventories.

To be able to design and model-assisted sampling techniques for forest inventories, and to be able to use the infinite population model for forest inventory. Two-stage two-phase forest inventories with simple or cluster sampling. Small area estimation. Presentation of the Swiss National Inventory.

Short introduction to Kriging techniques.

Students should have a good understanding of the concepts of general sampling theory in a modern framework. They should also master the specific problems arising in forest inventory and be able, if necessary, to read more specialized books or research papers.


Sampling techniques for forest inventories. Daniel Mandallaz, Chapman and Hall. A free electronic copy of the book is also available. A PDF file containing parts of the book will be mailed to the participants.


A simulation software will be used throughout the lectures to illustrate the theoretical developments. Upon request a half day field demonstration can be organized at the WSL outside the lecture time. A repertorium for the exam is also offered.
Stable Isotope Ecology of Terrestrial Ecosystems - W - 2 credits - R. A. Werner, N. Buchmann, A. Gessler

Abstract
This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to process-oriented ecological research. Topics focus on stable isotopes as indicators for the origin of pools and fluxes, partitioning of composite fluxes as well as to trace and integrate processes. In addition, students carry out a small project during lab sessions.

Objective
Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know the relevant approaches, concepts and recent results in stable isotope ecology, know how to combine classical and modern techniques to solve ecophysiological or ecological problems, learn to design, carry out and interpret a small IsoProject, practice to search and analyze literature as well as to give an oral presentation.

Content
The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools and fluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally.

Literature
Handouts will be available on the webpage of the course.

Prerequisites / notice
This course is based on fundamental knowledge about plant ecophysiology, soil science, and ecology in general. Course will be taught in English.

Earth Observation - W - 4 credits - I. Hajnsek, E. Baltisavias

Abstract
The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for bio/geophysical environmental parameter estimation.

Objective
The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for bio/geophysical environmental parameter estimation. Students should know at the end of the course:

1. Basics of measurement principle
2. Fundamentals of image acquisition
3. Basics of the sensor-specific geometries
4. Sensor-specific determination of environmental parameters

Content
Die Lehrveranstaltung gibt einen Einblick in die heutige Erdbearbeitung mit dem folgenden skizzierten Inhalt:

1. Einführung in die Fernerkundung von Luft- und Weltraum gestützten Systemen
2. Einführung in das Elektromagnetische Spektrum
3. Einführung in optische Systeme (optisch und hyperspektral)
4. Einführung in Mikrowellen-Technik (aktiv und passiv)
5. Einführung in atmosphärische Systeme (meteo und chemisch)
6. Einführung in die Techniken und Methoden zur Bestimmung von Umweltparametern
7. Einführung in die Anwendungen zur Bestimmung von Umweltparametern in der Hydrologie, Glaziologie, Forst und Landwirtschaft, Geologie und Topographie

Ecosystems
Abstract
Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures.

Objective
The students learn to critical assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.

Content
The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. You assess the sustainability of current land use and analyse management options improving nutrient and metal cycling in agro-ecosystems. The students will have the opportunity to calculate specific scenarios regarding land use management and environmental changes. Special focus we be paid on the soil services such as regulation-, production function and soil as habitat, and the assessment of these functions based on soil mapping data.

Literature
Foliensatz nach Vorlesung. Folien werden zur Verfügung gestellt.

Geographic Data Processing with Python and ArcGIS - W - 1 credit - A. Baltsweiler

Abstract
The course communicates the basics of the programming language Python and gives a general introduction into the geoprocessing framework of ArcGIS. In addition various Python libraries (numpy, Scipy, GDAL, statsmodels, pandas) will be introduced which increase the functional range of the geoprocessing framework substantially.

Objective
The students learn the basics of geographic data processing based on the programming language Python and ArcGIS (arcpy). They get the ability to implement their own processing sequences and models for geoprocessing. The students are able to integrate open source libraries in their python scripts and know how the libraries are applied to spatial datasets.

Content
The course communicates a deepened understanding of the geoprocessing frameworks arcpy and covers basic language concepts of Python such as datatypes, control structures and functions. In addition the application of popular Python libraries in combination with spatial datasets will be shown.

Literature

Dendroecology - W - 3 credits - C. Bigler, A. Rigling, K. Treydte

Abstract
The course dendroecology offers theoretical and practical aspects of dendrochronology. The impact of different environmental influences on tree-ring characteristics will be shown. The students learn various methods to date tree rings and they understand how ecological and environmental processes and patterns can be reconstructed using tree rings.
Inter- and Transdisciplinary Courses

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0015-00L</td>
<td>Seminar on Transdisciplinary Research for</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>C. E. Pohl, M. Staffacher</td>
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<td></td>
<td>Sustainable Development</td>
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**Abstract**
The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.

**Objective**
The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

**Content**
The seminar covers the following topics:
1. Theories and concepts of inter- and transdisciplinary research
2. The specific challenges of inter- and transdisciplinary research
3. Involving stakeholders
4. Collaborating disciplines
5. Exploration of tools and methods
6. Analysing participants' projects to improve inter- and transdisciplinary elements

**Literature**
Literature will be made available to the participants.

**Prerequisites / notice**
The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.

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<th>Number</th>
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<tbody>
<tr>
<td>701-1503-00L</td>
<td>CCES Winter School &quot;Science Meets Practice&quot;</td>
<td>W</td>
<td>4</td>
<td>9</td>
<td>C. Adler, P. Fry, P. Krüttli, C. E. Pohl</td>
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</table>

**Abstract**
Increasingly, scientists need to interact more with people and institutions outside the scientific community. This requires the capability to understand and critically reflect about scientific activities and consequences for society and environment and to communicate with confidence. The CCES Winter School builds capacity to create and manage interactions between science and society.

**Objective**
1. To acquire knowledge of key aspects of the interplay between science and practice
2. To reflect on and understand the role and consequences of scientific activity in relation to society and environment
3. To acquire skills and learn about a systematic application of methods to create and manage interactions between science and society
Content

The CCES Winter School provides insights into theoretical and methodological foundations on the challenges of knowledge exchange and dialogue between science and practice. It offers media and knowledge management training for enhancing stakeholder involvement. Selected case examples support group work discussions and analysis. Real stakeholder meetings are organized for testing techniques in view of identifying diverse expectations and needs and working towards solutions. Together the Winter School participants and stakeholders experience and develop ways for better linking environmental science and practice.

The course is structured by an intimate interconnection between theoretical inputs, reflection and translation into own topics and projects. The course offers insights into a wide spectrum of crossing boundaries between science and practice (e.g. information, consultation, co-production of knowledge) and provides test fields for and room for reflection of own experiences.

The first block with inputs, individual and group work, and reflection is a preparation for the second block, which focuses on implementation of stakeholder interactions. Between the two blocks coached project work is offered.

The CCES Winter School takes place at Propstei Wislikofen in January and February 2017. Accommodation is provided.

Course materials (e.g. slides, articles, toolboxes) are provided for preparatory reading and during the course (in Moodle).

Collection of key literature in online reader in Moodle.

The CCES Winter School addresses PhD students and postdocs from environmental and natural sciences, engineering, and social sciences related to sustainable development. Participants are required to apply online providing key information about their interest and PhD project - details and application form can be found here: http://www.cces.ethz.ch/winterschool/

The total time requirement is in the range of 120 hours, equivalent to 4 ECTS. The learning control focuses on i) active participation, engagement in case examples, and reflection against the background of own projects and experiences, 2) active team involvement in implementing tasks on information, consultation, and co-production of knowledge, including the design and organization of stakeholder meetings. The course is successfully completed by pass (pass/no pass, thus no marks). The language of the Winter School is English.

Stakeholder meetings will be in the local language (Swiss German) and translation into English is provided.

There is a participation fee of 400 CHF for the course, which is a contribution to the costs for the two blocks at the seminar venue Propstei Wislikofen, organizational support as well as material for the stakeholder meetings. Travel expenses to the venue are to be borne by the participants.

Basic and Scientific Skills

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<th>Number</th>
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<tr>
<td>701-0019-00L</td>
<td>Readings in Environmental Thinking</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>J. Ghazoul, G. Hirsch Hadorn, A. Patt</td>
</tr>
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</table>

Abstract

This course introduces students to foundational texts that led to the emergence of the environment as a subject of scientific importance, and shaped its relevance to society. Above all, the course seeks to give confidence and raise enthusiasm among students to read more widely around the broad subject of environmental sciences and management both during the course and beyond.

Objective

The course will provide students with opportunities to read, discuss, evaluate and interpret key texts that have shaped the environmental movement and, more specifically, the environmental sciences. Students will gain familiarity with the foundational texts, but also understand the historical context within which their academic and future professional work is based. More directly, the course will encourage debate and discussion of each text that is studied, from both the original context as well as the modern context. In so doing students will be forced to consider and justify the current societal relevance of their work.

Content

The course will be run as a book reading club. The first session will provide a short introduction as to how to explore a particular text (that is not a scientific paper) to identify the key points for discussion.

Thereafter, in each week a text (typically a chapter from a book or a paper) considered to be seminal or foundational will be assigned by a course lecturer. The lecturer will introduce the selected text with a brief background of the historical and cultural context in which it was written, with some additional biographical information about the author. He/she will also briefly explain the justification for selecting the particular text.

The students will read the text, with two to four students (depending on class size) being assigned to present it at the next session.

Presentation of the text requires the students to prepare by, for example:

- identifying the key points made within the text
- identifying issues of particular personal interest and resonance
- considering the impact of the text at the time of publication, and its importance now
- evaluating the text from the perspective of our current societal and environmental position

Such preparation would be supported by a mid-week tutorial discussion (about 1 hour) with the assigning lecturer.

These students will then present the text (for about 15 minutes) to the rest of the class during the scheduled class session, with the lecturer facilitating the subsequent class discussion (about 45 minutes). Towards the end of the session the presenting students will summarise the emerging points (5 minutes) and the lecturer will finish with a brief discussion of how valuable and interesting the text was (10 minutes).

In the remaining 15 minutes the next text will be presented by the assigning lecturer for the following week.

The specific texts selected for discussion will vary, but examples include:

- Leopold (1949) A Sand County Almanach
- Carson (1962) Silent Spring
- Jared Diamond (2005) Collapse

Discussions might also encompass films or other forms of media and communication about nature.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0017-00L</td>
<td>EAWAG PhD Skills Seminar</td>
<td>2</td>
<td>W</td>
<td>J. Jokela, J. Hering</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Purpose is to discuss and teach the professional skills that are needed in science (or future career in science). Course consists of lectures and practical sessions. Course is organized by Eawag scientists.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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</tr>
<tr>
<td></td>
<td>Purpose is to discuss and teach the professional skills that are needed in science (or future career in science). Course consists of lectures and practical sessions.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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</tr>
<tr>
<td></td>
<td>Lectures and exercises in:</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Project management</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Application of research grants</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Scientific publishing</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Reviewing</td>
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<tr>
<td></td>
<td>Writing papers</td>
<td></td>
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<td></td>
<td>Applying jobs</td>
<td></td>
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<tr>
<td></td>
<td>Job interviews</td>
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</tbody>
</table>

| 701-0763-00L | Basic Concepts of Management       | 2       | W    | R. Schwarzenbach   |
|             | **Abstract**                       |         |      |                    |
|             | This course deals with fundamental and proven management concepts. The lecturers emphasize the practical applicability of concepts. The course was designed in close cooperation with practitioners; e.g. will Mr. S. Baldenweg, mechanical engineer ETH, MBA Insead, share his experience in several guest lectures. |
|             | **Objective**                      |         |      |                    |
|             | Students:                          |         |      |                    |
|             | will be familiar with basic general management concepts. |
|             | will learn about the fundamental concepts of strategy development with practical examples. |
|             | will get to know the basic organisational issues and the essential types of organisations. |
|             | will give a rough overview on the concepts of financial management. |
|             | will learn about the strategic positioning of small departments within larger organisations. |
|             | will learn about the fundamental mechanisms for handling change, and will be able to recognise these situations. |
|             | will learn the basic principles of project management and of successful self-management. |
|             | will reflect on customer oriented information representation. |
|             | **Content**                        |         |      |                    |
|             | **Lecture notes**                  |         |      |                    |
|             | Skripten werden elektronisch zur Verfügung gestellt. |
|             | **Literature**                     |         |      |                    |
|             | Empfohlen werden folgende Titel für die Vertiefung einzelner Themen: |

| 851-0180-00L | Research Ethics                    | 2       | W    | G. Achermann       |
|             | **Abstract**                       |         |      |                    |
|             | This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences. |
|             | **Objective**                      |         |      |                    |
|             | The main goal of this course is to enhance the student's ability to: |
|             | - recognize and identify ethical issues and conflicts, |
|             | - analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter. |
|             | Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level. |
|             | To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises. |
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

► Additional Courses

Course Catalogue of ETH Zurich
### Doctoral Department of Environmental Sciences - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
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### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

### ECTS

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.


Electrical Engineering and Information Technology Bachelor

altarStudies (Programme Regulations 2016)

1. Semester

First Year Examinations

First Year Examination Block A

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0003-00L</td>
<td>Digital Circuits</td>
<td>O</td>
<td>4</td>
<td>2v+2u</td>
<td>G. Tröster</td>
</tr>
<tr>
<td>Abstract</td>
<td>Digital and analogue signals and their representation. Combinational and sequential circuits and systems, boolean algebra, K-maps. Finite state machines. Memory and computing building blocks in CMOS technology, programmable logic circuits.</td>
<td></td>
<td></td>
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<tr>
<td>Objective</td>
<td>Provide basic knowledge and methods to understand and to design digital circuits and systems.</td>
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</tr>
<tr>
<td>Content</td>
<td>Digital and analogue signals and their representation. Boolean Algebra, circuit analysis and synthesis, the MOS transistor, CMOS logic, static and dynamic behaviour, tristate logic, Karnough-Maps, hazards, binary number systems, coding. Combinational and sequential circuits and systems (boolean algebra, K-maps, etc.). Memory building blocks and memory structures, programmable logic circuits. Finite state machines, architecture of microprocessors.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Lecture notes for all lessons, assignments and solutions.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>No special prerequisites</td>
<td></td>
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</tbody>
</table>

| 401-0151-00L    | Linear Algebra                 | O    | 4    | 3G+2U | V. C. Gradinaru, R. Käppeli |
| Abstract        | Contents: Linear systems - the Gaussian algorithm, matrices - LU decomposition, determinants, vector spaces, least squares - QR decomposition, linear maps, eigenvalue problem, normal forms - singular value decomposition; numerical aspects; introduction to MATLAB. |
| Objective       | Einführung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte |
| Lecture notes   | K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, S. Auflage 2002 |
| Literature      | K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, S. Auflage 2002 |

| 227-0001-00L    | Networks and Circuits I        | O    | 4    | 2v+2u | J. W. Kolar      |
| Abstract        | Electrostatic field; Stationary electric current flow; Basic electric circuits; current conduction mechanisms; time variant electromagnetic field; alternating voltages and currents. |
| Objective       | Voltage, current and properties of basic elements of electric circuits, i.e. capacitors, resistors and inductors should be understood in relation to electric and magnetic fields. Furthermore, the students should be able to mathematically describe, analyze and finally design technical realizations of circuit elements. Students should also be familiar with the calculation of voltage and current distributions of DC circuits. The effect and the mathematical formulation of magnetic induction should be known for technical applications. The fundamentals of complex AC current calculus for description of periodic sinusoidal quantities should be known and students should be able to apply the concept to basic AC circuits. |
| Content         | Electrostatic field; Stationary electric current flow; Basic electric circuits; current conduction mechanisms; time variant electromagnetic field; alternating voltages and currents. |
| Lecture notes   | Grundlagen der Elektrotechnik, Bd. 1 und 2, M. Albach, and Textbook |
| Literature      | Grundlagen der Elektrotechnik |

| 151-0223-10L    | Engineering Mechanics          | O    | 4    | 2v+2u+1K | S. P. Kaufmann, J. Dual |
| Abstract        | Introduction to engineering mechanics: kinematics, statics and dynamics of rigid bodies and systems of rigid bodies. |
| Objective       | Students can solve problems of elementary engineering mechanics. |
| Content         | Statics: static equivalence, force-couple system, center of forces, centroid, principle of virtual power, equilibrium, constraints, statics, friction. Dynamics: acceleration, inertial forces, d'Alembert's Principle, Newton's Second Law, principles of linear and angular momentum, equations of planar motion of rigid bodies. |
| Lecture notes   | yes |
| Prerequisites / notice | Three optional midterm exams are offered. If improving, the mean of the two better midterm exams counts with weight 30% to the final grade. |

First Year Examination Block B

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-0231-10L</td>
<td>Analysis I</td>
<td>O</td>
<td>8</td>
<td>4v+3u</td>
<td>D. A. Salamon</td>
</tr>
<tr>
<td>Abstract</td>
<td>Calculus of one variable: Real and complex numbers, vectors, limits, sequences, series, power series, continuous maps, differentiation and integration in one variable, introduction to ordinary differential equations</td>
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</tr>
<tr>
<td>Objective</td>
<td>Einfuehrung in die Grundlagen der Analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Konrad Koenigsberger, Analysis I. Christian Blatter: Ingenieur-Analysis (Kapitel 1-3)</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
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</tbody>
</table>

| 252-0835-00L    | Computer Science I             | O    | 4    | 2v+2u | F. O. Friedrich |
| Abstract        | | | | | |
| Objective       | | | | | |
| Lecture notes   | | | | | |
| Literature      | | | | | |
| Prerequisites / notice | | | | | |
Abstract
The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Teached language is C++. No programming experience is required.

Objective
Primary educational objective is to learn programming with C++. When successfully attended the course, students have a good command of the mechanisms to construct a program. They know the fundamental control and data structures and understand how an algorithmic problem is mapped to a computer program. They have an idea of what happens "behind the scenes" when a program is translated and executed.

Secondary goals are an algorithmic computational thinking, understanding the possibilities and limits of programming and to impart the way of thinking of a computer scientist.

Content
The course covers fundamental data types, expressions and statements, (Limits of) computer arithmetic, control statements, functions, arrays, structural types and pointers. The part on object orientiation deals with classes, inheritance and polymorphy, simple dynamic data types are introduced as examples.

In general, the concepts provided in the course are motivated and illustrated with algorithms and applications.

Lecture notes
A script written in English will be provided during the semester. The script and slides will be made available for download on the course web page.

Literature
Bjarne Stroustrup: Einführung in die Programmierung mit C++, Pearson Studium, 2010

Prerequisites / notice
From AS 2013, an admission to the exam does not any more formally require an attending of the recitation sessions. Handing in solutions to the weekly exercise sheets is thus not mandatory, but we strongly recommend it.

Examination is a one hour-long written test.

First Year Compulsory Laboratory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0005-10L</td>
<td>Digital Circuits Laboratory</td>
<td>O</td>
<td>1 credit</td>
<td>1P</td>
<td>G. Tröster</td>
</tr>
</tbody>
</table>

Abstract
Digital and analogue signals and their representation. Combinational and sequential circuits and systems, boolean algebra, K-maps. Finite state machines. Memory and computing building blocks in CMOS technology, programmable logic circuits.

Objective
Deepen and extend the knowledge from lecture and exercises, usage of design software Quartus II as well as an oscilloscope

Content
The contents of the digital circuits laboratory will deepen and extend the knowledge of the correspondent lecture and exercises. With the help of the logic device design software Quartus II different circuits will be designed and then tested on an evaluation board. You will build up the control for a 7-digit display as well as an adder and you will create different types of latches and flip-flops. At the end of the laboratory a small synthesizer will be programmed that is able to play self-created melodies. At the same time the usage of a modern oscilloscope will be taught in order to analyse the programmed circuits through the digital and analogue inputs.

Bachelor Studies (Programme Regulations 2012)

1. Semester

Course Units of the first year can be found in section Bachelor Studies (Programme Regulations 2016) - 1. Semester

3. Semester

Examination Blocks

1. Semester

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0353-00L</td>
<td>Analysis III</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

Abstract
In this lecture we treat problems in applied analysis. The focus lies on the simplest cases of three fundamental types of partial differential equations of second order: the Laplace equation, the heat equation and the wave equation.

Content
1.) Klassifizierung von PDE's
- linear, quasilinear, nicht-linear
- elliptisch, parabolisch, hyperbolisch

2.) Quasilineare PDE
- Methode der Charakteristiken (Beispiele)

3.) Elliptische PDE
- Bsp: Laplace-Gleichung
- Harmonische Funktionen, Maximumsprinzip, Mittelwerts-Formel.
- Methode der Variablenseparation.

4.) Parabolische PDE
- Bsp: Wärmeleitungsgleichung
- Bsp: Inverse Wärmeleitungsgleichung
- Methode der Variablenseparation

5.) Hyperbolische PDE
- Bsp: Wellengleichung
- Formel von d'Alembert in (1+1)-Dimensionen
- Methode der Variablenseparation

6.) Greensche Funktionen
- Rechnen mit der Dirac-Deltafunktion
- Idee der Greenschen Funktionen (Beispiele)

7.) Ausblick auf numerische Methoden
- 5-Punkt-Diskretisierung des Laplace-Operators (Beispiele)

Literature

Zusätzliche Literatur:
Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, Kap. 8, 11, 16 (sehr gutes Buch, als Referenz zu benutzen)
Norbert Hungerbühler, "Einführung in die partiellen Differentialgleichungen", vdf Hochschulverlag AG an der ETH Zürich.

Prerequisites / notice
Prerequisites: Analysis I and II, Fourier series (Komplexe Analysis)
Physics II
The goal of the Physics II class is an introduction to quantum mechanics (lecture given in German)

Objective
Die gegenwärtigen Entwicklung von Ingenieurwissenschaften verlangen, dass auch StudentInnen dieser Fächer die Grundlagen der Quantenmechanik und Festkörperphysik (mit den Bandstrukturen) beherrschen. Es ist das Ziel dieser Vorlesung das Gebiet der Quantenmechanik auf einem Weg einzuführen, der zwar elementar ist, es aber ermöglicht die quantenmechanische Begriffe auf die verschiedensten Situationen anzuwenden.

Content
Kap. 1-Teil 1 Die Grundlagen der elektromagnetischen Wellen und der Quantenphysik
Wärmestrahlung, Elektromagnetisches Spektrum, Ausgangspunkt Maxwellgleichungen und Materialgleichungen für die Herleitung der Wellengleichung (Skript wird verteilt), Lösung der Wellengleichung: ebene Welle, Wellenfronten, Dispersion, Photonenlektrotrische Emission, Photonen, Dualismus Teilchen-Welle bei Photonen, Interferenz, Wellenpacket (Skript wird verteilt)

Kap. 1-Teil 2 Die Grundlagen der Quantenphysik
Streuung von Strahlungen durch freie Elektronen, Compton-Effect, Impuls von Photonen, Bohrsche Atommodell und stationäre Zustände, Impulserhaltung bei Absorption und Emission von Photonen, Dualismus Teilchen-Welle bei Elektronen, Materiewelle, Beugung (Skript wird verteilt), Heisenbergsche Unschärferelationen

Kapitel 2: Quantenmechanik
Wellenfunktion und Wahrscheinlichkeitsdichte, Schrödingergleichung, freies Teilchen, Dispersion der Materiewelle, Potentialstufe, Tunneleffekt, Teilchen im Potentialekisten, harmonische Oszillator, zeitabhängige Schrödingergleichung, formale Theorie der Quantenmechanik (Operator, Observable, Eigenwert, Erwartungswert, Kommutator)

Kapitel 3: Atome mit einem Elektron
Wasserstoffatom, Quantisierung des Drehimpulses, Einführung der Wellenfunktion in Zentralfeldern (Atomorbital), Zeeman-Effect, Elektronenspin, Spin-Bahn-Wechselwirkung

Kapitel 4: Atome mit vielen Elektronen
Born-Oppenheimer Näherung, Heliumatom, Ausschliessungsprinzip von Pauli, Periodensystem, Elektronenstruktur der Atome, Röntgenspektren, Auswahlregeln

Kapitel 5: Moleküle
Wasserstoffmolekül-Ion, Moleküwellenfunktion zweiatomiger Moleküle, Kovalente Bindung, Hybrid-Orbital, Molekule Rotation und Schwingung

Kapitel 6 und 13: Festkörper und Quantenstatistik
Typen der Festkörper, Bändermodell der Festkörper, "Tight Binding Model" explizit hergeleitet, Modell der freien Elektronen, Elektronenbewegung in einer periodischen Struktur, "effective mass approximation", Leiter, Isolator und Halbleiter, Quantentheorie der elektrischen Leitfähigkeit, Fermienergie, Löcher, Strahlungsübergänge in Festkörpern, Fermi-Dirac Statistik, Zustandsdichte, Bose-Einstein Statistik, Herleitung Plancksche Strahlungsgesetz, Elektronen in Metallen und Halbleiter (Anwendung der Fermi-Dirac Verteilung), Dotierungen in Halbleitern

Lecture notes
Lehrbuch
Alonso, Marcelo / Finn, Edward J. Quantenphysik und Statistische Physik

Prerequisites / notice
Prerequisites: Physics I.
Modern, transistor-based electronics has transformed our lives and plays a crucial role in our economy since the 2nd half of last century. The main objective of this course in electronic circuits is to introduce the concept of active device, including operational amplifiers, and their use in amplification, signal conditioning, switching and filtering to students. In addition to gaining experience with typical electronic circuits that are found in common applications, including their own Gruppenarbeit and Fachpraktikum projects, students sharpen their understanding of linear circuits based on nonlinear devices, imperfections of electronic circuits and the concept of design (as opposed to analysis). The course is a prerequisite for higher semester subjects such as analog integrated circuits, RF circuits for wireless communications, A/D and D/A converters and optoelectronics.


401-0053-00L Discrete Mathematics O 4 credits 2V+1U R. Zenklusen

Abstract
Introduction to foundations of discrete mathematics: combinatorics (elementary counting), graph theory, algebra, and applications thereof.

Objective
The main goal is to get a good understanding of some of the most prominent areas within discrete mathematics.

Exam Block 3
The courses of the examination block 3 will be offered in spring semester.

Second Year Compulsory Laboratory Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>227-0079-10L</td>
<td>Electronic Circuits Laboratory</td>
<td>O</td>
<td>1 credit</td>
<td>1P</td>
<td>Q. Huang</td>
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<tr>
<td>Abstract</td>
<td>Lab with principal electronic circuit experiments on the transistor and operational amplifier basis.</td>
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<tr>
<td>Objective</td>
<td>Modern, transistor-based electronics has transformed our lives and plays a crucial role in our economy since the 2nd half of last century. The main objective of this course in electronic circuits is to introduce the concept of active device, including operational amplifiers, and their use in amplification, signal conditioning, switching and filtering to students. In addition to gaining experience with typical electronic circuits that are found in common applications, including their own Gruppenarbeit and Fachpraktikum projects, students sharpen their understanding of linear circuits based on nonlinear devices, imperfections of electronic circuits and the concept of design (as opposed to analysis). The course is a prerequisite for higher semester subjects such as analog integrated circuits, RF circuits for wireless communications, A/D and D/A converters and optoelectronics.</td>
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<tr>
<td>Content</td>
<td>Get to know and understand basic transistor and op amp based electronic circuits. Build and operate simple electronic circuits including supply decoupling. Carry out and understand different, principal measurement methods such as DC- and AC-analysis, time and frequency domain measurements, impedance and transfer function measurements. In the lab we will have a closer look at the following topics and circuits: characterization of a real capacitor includingnon-idealties; common-emitter transistor amplifier with emitter degeneration; characterization of a real operational amplifier with non-idealties; band pass filter with op amp, resistors and capacitors; data converters; oscillator and function generator based on an op amp.</td>
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Laboratory Courses, Projects, Seminars
A minimum of 18 cp must be obtained from the category "Laboratory Courses, Projects, Seminars".

General Laboratory

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<tr>
<th>Number</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>227-0095-10L</td>
<td>General Laboratory I</td>
<td>Only for Electrical Engineering and Information Technology BSc.</td>
<td>W</td>
<td>2 credits</td>
<td>2P</td>
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<tr>
<td>Abstract</td>
<td>Enrolment via Online-Tool (EE-Website: Studies -&gt; Bachelor Program -&gt; Third Year -&gt; Laboratory Courses)</td>
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<tr>
<td>Objective</td>
<td>The Laboratory courses in the 5th and 6th semesters enable the students to put the the contents of the courses from the four first semesters to the test and to consolidate the acquired knowledge. Furthermore students have the possibility to gain specific knowledge in certain software packages as MATLAB.</td>
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<tr>
<td>227-0096-10L</td>
<td>General Laboratory II</td>
<td>Only for Electrical Engineering and Information Technology BSc.</td>
<td>W</td>
<td>4 credits</td>
<td>4P</td>
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Projects & Seminars
A maximum of 13 cp can be obtained from Projects & Seminars. Each course can be registered for only once.

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<tr>
<td>227-0085-10L</td>
<td>Projects &amp; Seminars for 1 CP (1)</td>
<td>Only for Electrical Engineering and Information Technology BSc.</td>
<td>W</td>
<td>1 credit</td>
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</table>
Abstract
Procurement of knowledge about the build up of systems as well as enhancement of general knowledge.
Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during ones work life.

Objective
see above

Prerequisites / notice
Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

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<tr>
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<tr>
<td>227-0085-50L</td>
<td>Projects &amp; Seminars for 3 CP</td>
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<tbody>
<tr>
<td>227-0085-60L</td>
<td>Projects &amp; Seminars for 4 CP</td>
<td>W</td>
<td>4 credits</td>
<td>4P</td>
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Group Projects

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<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0091-10L</td>
<td>Group Project I</td>
<td>W</td>
<td>6 credits</td>
<td>5A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>Students must work in groups in supervised projects for 150 to 180 hours minimum. The topics of the group work are open and can be technical of specific nature or more general in the context of engineering.</td>
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<th>Hours</th>
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<tbody>
<tr>
<td>227-0092-10L</td>
<td>Group Project II</td>
<td>W</td>
<td>6 credits</td>
<td>5A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>Students must work in groups in supervised projects for 150 to 180 hours minimum. The topics of the group work are open and can be technical of specific nature or more general in the context of engineering.</td>
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Internship in Industry
Please note the conditions for Internships in industry as set forward by the "Guidelines for the "Laboratory Courses - Projects - Seminars ", see https://www.ee.ethz.ch/content/dam/ethz/special-interest/let/department/Studies/Bachelor/Regulations/Richtlinien_Praktika-Projekte-Seminare_v5_final.pdf (German only).

Number Title Type ECTS Hours Lecturers
227-0093-10L Internship in Industry W 6 credits external organisers

Abstract
The main objective of the 12-week internship is to expose bachelor's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective
Please note the conditions for Internships in industry as set forward by the "Guidelines for the "Laboratory Courses - Projects - Seminars ", see https://www.ee.ethz.ch/content/dam/ethz/special-interest/let/department/Studies/Bachelor/Regulations/Richtlinien_Praktika-Projekte-Seminare_v5_final.pdf (German only).

Number Title Type ECTS Hours Lecturers
227-0651-00L Applied Circuit and PCB-Design W 2 credits 4G A. Blanco Fontao

Abstract
Participants learn how to design a predefined electronic circuit and how to lay out the pertaining circuit board. CAE and CAD activities for design and simulation are carried out with the aid of Altium Designer.

Objective
The goal is to become acquainted with all those practical aspects of electronic circuit and PCB design by working through a modest but complete application example. This involves analysis of specifications, the evaluation of electronic parts, efficient testing and failure search, electromagnetic compatibility (EMC), the usage of industrial CAE/CAD tools for circuit simulation and PCB layout, generating production data for the board manufacturer, board mounting, testing and start up.

Content
- Understanding circuit, system, and product specifications
- Guidelines, standards, and regulations
- Design and development flow
- Introduction to the Altium Designer environment
- Selection of components and circuit sizing
- Preparing schematic symbols and footprints for CAE/CAD
- Working with database component libraries
- Logically structured schematic circuit diagrams
- Capturing a predefined circuit
- Definition of net classes and layout rules in schematics
- Design for EMC
- Checking schematic data
- Simulation of mixed signal circuits using Spice
- Hints for improved testing and debugging
- Component placement on the PCB
- Turning circuit diagrams into a workable layout
- Manual and automatic interconnect routing
- Definition of layout rules
- RF- and EMC-guidelines for circuit wire routing
- Differential pairs and impedance-controlled routing
- Introduction to PCB manufacturing
- Preparation of production and assembly data
- PCB and device assembly (component mounting)
- Final circuit testing and start up

Literature
All necessary documents will be available as electronic documents (PDF).

Prerequisites / notice
- The course is recommended to all students who plan to design an electronic circuit or a PCB in an upcoming term project or as part of their master thesis. Attending this course during the term before will ensure they are optimally prepared and will allow them to fully focus on their project.
- The number of participants is limited.
- For their own students and staff, the Department of Information Technology and Electrical Engineering provides electronic components and consumables free of charge. All other participants have to bear a 200 CHF fee for those items.

Third Year Core Courses
Can be freely combined, a list of recommendations is available under www.ee.ethz.ch/bachelor-kernfaecher

Number Title Type ECTS Hours Lecturers
227-0101-00L Discrete-Time and Statistical Signal Processing W 6 credits 4G H.A. Loeliger

Abstract
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.

Objective
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are linearity and probability. In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm. A recurrent theme throughout the course is the stable and robust "inversion" of a linear filter.
1. Discrete-time linear systems and filters:
state-space realizations, z-transform and spectrum,
declination and interpolation, digital filter design,
stable realizations and robust inversion.

2. The discrete Fourier transform and its use for digital filtering.

3. The statistical perspective:
probability, random variables, discrete-time stochastic processes;
detection and estimation: MAP, ML, Bayesian MMSE, LMMSE;
Wiener filter, LMS adaptive filter, Viterbi algorithm.

Lecture notes
Lecture Notes.

227-0102-00L Discrete Event Systems W 6 credits 4G L. Thiele, L. Vanbever, R. Wattenhofer

Abstract
Introduction to discrete event systems. We start out by studying popular models of discrete event systems, in the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

Objective
Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.

Content
1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

Literature
[bertsekas] Data Networks
Dimitri Bersekas, Robert Gallager

[borodin] Online Computation and Competitive Analysis
Allan Borodin, Ran El-Yaniv
Cambridge University Press, 1998

[boudec] Network Calculus
J.-Y. Le Boudec, P. Thiran
Springer, 2001

[cassandras] Introduction to Discrete Event Systems
Christos Cassandras, Stéphane Lafortune

[fiat] Online Algorithms: The State of the Art
A. Fiat and G. Woeginger

D. Hochbaum

[schickinger] Diskrete Strukturen (Band 2: Wahrscheinlichkeitstheorie und Statistik)
T. Schickinger, A. Steger
Springer, Berlin, 2001

[sipser] Introduction to the Theory of Computation
Michael Sipser

227-0103-00L Control Systems W 6 credits 2V+2U F. Dörfler

Abstract
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Objective
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Content
An skript including animated wave representations is provided in electronic form. The behavior of electromagnetic waves both in free space and in selected environments including stratified media, material interfaces and waveguides is understood. Material models in the time harmonic regime including negative index and plasmonic materials are clarified.

Description of generic time harmonic electromagnetic fields; the role of the material in Maxwell's equations; energy transport and power loss mechanism; EM-waves in homogeneous space; ordinary and evanescent plane waves, cylindrical and spherical waves, "complex origin"-waves and beams; EM-waves in stratified media; generic guiding mechanism for EM waves; classical wave guides, dielectric waveguides.

A skript including animated wave representations is provided in electronic form. The behavior of electromagnetic waves both in free space and in selected environments including stratified media, material interfaces and waveguides is understood. Material models in the time harmonic regime including negative index and plasmonic materials are clarified.

Description of generic time harmonic electromagnetic fields; the role of the material in Maxwell's equations; energy transport and power loss mechanism; EM-waves in homogeneous space; ordinary and evanescent plane waves, cylindrical and spherical waves, "complex origin"-waves and beams; EM-waves in stratified media; generic guiding mechanism for EM waves; classical wave guides, dielectric waveguides.

Lecture notes
Literature
Prerequisites / notice
See literature list in the script.
The lecture is taught in German while both the script and the viewgraphs are in English.

227-0110-00L
Advanced Electromagnetic Waves
This course has been moved from the spring to the fall semester for the academic year of 2016/17. It will therefore not take place in spring 2017.

Abstract
This course provides advanced knowledge of electromagnetic waves in linear materials including negative index and other non classical materials.

Objective
The behavior of electromagnetic waves both in free space and in selected environments including stratified media, material interfaces and waveguides is understood. Material models in the time harmonic regime including negative index and plasmonic materials are clarified.

Content
Description of generic time harmonic electromagnetic fields; the role of the material in Maxwell's equations; energy transport and power loss mechanism; EM-waves in homogeneous space; ordinary and evanescent plane waves, cylindrical and spherical waves, "complex origin"-waves and beams; EM-waves in stratified media; generic guiding mechanism for EM waves; classical wave guides, dielectric waveguides.

Lecture notes
Literature
Prerequisites / notice
A skript including animated wave representations is provided in electronic form.

227-0110-00L
High-Speed Signal Propagation
Understanding of high-speed signal propagation in microwave cables and printed circuit boards.

Abstract
As clock frequencies rise in the GHz domain, there is a need grasp signal propagation to maintain good signal integrity in the face of symbol interference and cross-talk.

Objective
Understanding of high-speed signal propagation in interconnects, microwave cables and integrated transmission lines such as microwave integrated circuits and/or printed circuit boards.

Content

Lecture notes
Prerequisites / notice
B utterworth-, Chebychev- and Bessel filter approximations: filter synthesis from low-pass filter prototypes.

227-0113-00L
Power Electronics
Fields of application of power electronic systems. Principle of operation of basic pulse-width modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

Abstract
Fields of application of power electronic systems. Principle of operation of basic pulse-width modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

Objective
Fields of application of power electronic systems. Principle of operation of basic pulse-width modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

Content

Lecture notes
Prerequisites / notice
Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.

227-0121-00L
Communication Systems
Information Theory, Signal Space Analysis, Baseband Transmission, Passband Transmission, Example und Channel, Data Link Layer, MAC, Example Layer 2, Layer 3, Internet

Abstract
Introduction into the fundamentals of digital communication systems. Selected examples on the application of the fundamental principles in existing and upcoming communication systems

Objective
Covered are the lower three layer of the OSI reference model: the physical, the data link, and the network layer. The basic terms of information theory are introduced. After this, we focus on the methods for error detection and correction as well as protocols for the retransmission of perturbed data will be covered. Also the medium access for systems with shared medium will be discussed. Finally, algorithms for routing and flow control will be treated.

Content
The application of the basic methods will be extensively explained using existing and future wireless and wired systems.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Semester</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0122-00L</td>
<td>Introduction to Electric Power Transmission: System &amp; Technology</td>
<td>W</td>
<td>6</td>
<td>C. Franck, G. Hug</td>
</tr>
<tr>
<td>227-0145-00L</td>
<td>Solid State Electronics and Optics</td>
<td>W</td>
<td>6</td>
<td>4G V. Wood</td>
</tr>
<tr>
<td>227-0166-00L</td>
<td>Analog Integrated Circuits</td>
<td>W</td>
<td>6</td>
<td>2V+2U Q. Huang</td>
</tr>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>5G S. Kozerke, K. P. Prüssmann, M. Rudin</td>
</tr>
<tr>
<td>227-0393-10L</td>
<td>Bioelectronics and Biosensors</td>
<td>W</td>
<td>6</td>
<td>2V+2U J. Vörös, M. F. Yanik, T. Zambelli</td>
</tr>
</tbody>
</table>

**Objective**

- During this course the students will:
  - learn the basic concepts in biosensing and bioelectronics
  - be able to solve typical problems in biosensing and bioelectronics
  - learn about the remaining challenges in this field

**Lecture Notes**

- Lecture Slides
- Handouts of presented slides. No script but an accompanying textbook is recommended.

**Literature**

- Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011
- Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming
Content

L1. Bioelectronics history, its applications and overview of the field
   - Volta and Galvani dispute
   - BMI, pacemaker, cochlear implant, retinal implant, limb replacement devices
   - Fundamentals of biosensing
   - Glucometer and ELISA

L2. Fundamentals of quantum and classical noise in measuring biological signals

L3. Biomeasurement techniques with photons

L4. Acoustics sensors
   - Differential equation for quartz crystal resonance
   - Acoustic sensors and their applications

L5. Engineering principles of optical probes for measuring and manipulating molecular and cellular processes

L6. Optical biosensors
   - Differential equation for optical waveguides
   - Optical sensors and their applications
   - Plasmonic sensing

L7. Basic notions of molecular adsorption and electron transfer
   - Quantum mechanics: Schrödinger equation energy levels from H atom to crystals, energy bands
   - Electron transfer: Marcus theory, Gerischer theory

L8. Potentiometric sensors
   - Fundamentals of the electrochemical cell at equilibrium (Nernst equation)
   - Principles of operation of ion-selective electrodes

L9. Amperometric sensors and bioelectric potentials
   - Fundamentals of the electrochemical cell with an applied overpotential to generate a faraday current
   - Principles of operation of amperometric sensors
   - Ion flow through a membrane (Fick equation, Nernst equation, Donnan equilibrium, Goldman equation)

L10. Channels, amplification, signal gating, and patch clamp Y4

L11. Action potentials and impulse propagation

L12. Functional electric stimulation and recording
   - MEA and CMOS based recording
   - Applying potential in liquid - simulation of fields and relevance to electric stimulation

L13. Neural networks memory and learning

Literature
Plonsey and Barr, Bioelectricity: A Quantitative Approach (Third edition)

Prerequisites / notice
Supervised exercises solving real-world problems. Some Matlab based exercises in groups.

Electives
This is but a short selection. Other courses from the ETH course catalogue may be chosen. Please consult the “Richtlinien zu Projekten, Praktika, Seminaren” (German only), published on our website (http://www.ee.ethz.ch/pps-richtlinien).

Economics, Law and Management Electives
These subjects are particularly suitable for students planning to apply to the Master's Degree Program in Energy Science and Technology (MSc EST) or Management, Technology and Economics (MSc MTEC).

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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Abstract
Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Objective
Discovering Management combines in an innovate format a set of lectures and an advanced business game. The learning model for Discovering Management involves 'learning by doing'. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 501 of 1571
Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the interdependence of various topics in the development and management of a firm. The lectures introduce students not only to topics relevant for managing large corporations, but also touch upon the different aspects of starting up your own venture. The lectures will be presented by the respective area specialists at D-MTEC.

The course broadens the view and understanding of technology by linking it with its commercial applications and with society. The lectures are designed to introduce students to topics related to strategy, corporate innovation, leadership, corporate and entrepreneurial finance, value chain analysis, corporate social responsibility, and business model innovation. Practical examples from industry experts will stimulate the students to critically assess these issues. Creative skills will be trained by the business game exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of Chief Innovation Officer of a large multinational company. As they learn more about the specific case and identify the challenge they are faced with, the students will have to develop an innovative business case for this multinational corporation. Doing so, this exercise will provide an insight into the context of managerial problem-solving and corporate innovation, and enhance the students' appreciation for the complex tasks companies and managers deal with.

The business game presents a realistic model of a company and provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyse the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

Prerequisites:

- Prior knowledge of business or economics is required to successfully complete this course.

**363-0305-00L**

**Empirical Methods in Management**

| W | 3 credits | 2G | A. Scherer |

**Abstract**

Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.

**Objective**

- Ability to formulate research questions and designing an appropriate study
- Ability to collect and analyze data using a variety of methods
- Ability to critically assess the quality of empirical research in management
- Applied knowledge of empirical methods through out-of-class assignments

**Content**

1) Introduction to empirical management research
2) Research designs: exploratory, descriptive, experimental
3) Measurement and scaling
4) Data collection and sampling
5) Data analysis methods
6) Reporting and presenting empirical research

**Prerequisites / notice**

Assignments and projects: This course includes out-of-class assignments and projects to give students some hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. Students will have at least one week to work on each assignment. Students are expected to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned-in on time.

Class participation: Class participation is encouraged and can greatly improve students' learning in this class. In this spirit, students are expected to attend class regularly and come to class prepared.

**363-0503-00L**

**Principles of Microeconomics**

| W | 3 credits | 2G | M. Filippini |

**Abstract**

The course introduces basic principles, problems and approaches of microeconomics.

**Objective**

The learning objectives of the course are:

1) Students must be able to discuss basic principles, problems and approaches in microeconomics. (2) Students can analyse and explain simple economic principles in a market using supply and demand graphs. (3) Students can contrast different market structures and describe firm and consumer behaviour. (4) Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole. (5) Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.

**Lecture notes**

Lecture notes, exercises and reference material can be downloaded from Moodle.

**Literature**

- The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:


Complementary:


**363-0511-00L**

**Managerial Economics**

| W | 4 credits | 3V | S. Rausch, V. Hoffmann |

**Abstract**

Managerial Economics applies economic theory and methods to business and economic decision-making. Economic ideas related to optimization, the theory of consumer demand, the theory of the firm, industrial organization and decision making under uncertainty are studied using methods of numerical analysis, statistical estimation, game theory and constrained optimization.

**Objective**

The objective of the course is to provide undergraduate and graduate students in MAVT with an understanding of the use of economic concepts for firm-level management decisions. The course covers a number of models and methods of analysis which are commonly employed in business decisions. The course covers the economic theory of choice, models of oligopoly and industrial organization, applications of game theory to contract design and agency theory, and the theory of decisions under uncertainty focusing specifically on long-term investment decisions. The course will include three lectures by Professor Volker Hoffman focusing on related case-studies in management.

**Literature**

Mikroøkonomie (Pearson Studium - Economic VWL) Gebundene Ausgabe, August 2013, Robert S. Pindyck, Dr. Daniel L. Rubinfeld.

The course acquaints students who have previous not studied economics to economic concepts and quantitative methods which can be used to solve management decision problems.

**851-0703-00L**

**Introduction to Law**

| W | 2 credits | 2V | O. Streiff Gnøpff |

**Abstract**

This class introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered.

- Particularly suitable for students of D-MAVT, D-MATL

**Abstract**

Students who have attended or will attend the lecture "Introduction to Law for Civil Engineering and Architecture" or "Introduction to Law" (851-0708-00), cannot register for this course unit.

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 502 of 1571
Students are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes.

Basic concepts of law, sources of law.
Private law: Contract law (particularly contract for work and services), tort law, property law.
Public law: Human rights, administrative law, procurement law, procedural law.

Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=2170).

Handouts (available online)

The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights).

The aim of this course is to enable students at ETH Zurich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.

Another goal is to enable the students to participate in the current debate over the goals and desirability of protecting intellectual creations, particularly in the areas of copyright (keywords: fair use, Creative Commons, Copyleft) and patent law (software patents, patent trolls, patent thicket).

The lecture gives an overview of the fundamental aspects of intellectual property, which plays an important role in the daily routine of engineers. The lecture aims to make participants aware of the various methods of protection and to put them in a position to use this knowledge in the workplace.

In recent years, knowledge about intellectual property has become increasingly important for engineers. Both in production and distribution and in research and development, engineers are increasingly being confronted with questions concerning the patenting of technical inventions and the use of patent information.

The lecture will acquaint students with practical aspects of intellectual property and enable them to use the acquired knowledge in their future professional life.

Topics covered during the lecture will include:
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups.

Case studies will illustrate and deepen the topics addressed during the lecture.

The seminar will comprise practical exercises on how to use and search patent information. Basic knowledge of how to read and evaluate patent documents as well as how to use publicly available patent databases to obtain the required patent information will also be provided.

The lecture is in particular tailored to the needs of the following degree programs: Agricultural science, architecture, civil engineering, computational science and engineering, computer science, electrical engineering and information technology, environmental engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-related degree programs, the lecture 'Protecting inventions in chemistry' (851-0738-03) will be offered in the autumn semester.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0621-00L</td>
<td>Microsystems Technology</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>C. Hierold, M. Haluska</td>
</tr>
</tbody>
</table>

Students are introduced to the basics of micromachining and silicon process technology and will understand the fabrication of microsystems and -devices by a sequence of defined processing steps (process flow).

Introduction to microsystems technology (MST) and micro electro mechanical systems (MEMS)
Basic silicon technologies: Thermal oxidation, photolithography and etching, diffusion and ion implantation, thin film deposition.
Specific microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresistive materials.
Selected microsystems: Mechanical sensors and actuators, microresonators, thermal sensors and actuators, system integration and encapsulation.

Handouts (available online)
Introduction to Biomedical Engineering I

Prerequisites / notice

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0802-01L</td>
<td>Introduction to Biomedical Engineering I</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>P. Christen, R. Müller, J. G. Snedeker, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

Abstract
Introduction to biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering.

Objective
Understanding of physical and technical principles in biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering. Mathematical description and problem solving. Knowledge of biomedical engineering applications in research and clinical practice.

Content
Tissue and Cellular Biomechanics, Molecular Biomechanics and Biopolymers, Computational Biomechanics, Biomaterials, Tissue Engineering, Radiation and Radiographic Imaging, Diagnostic Ultrasound Imaging, Magnetic Resonance Imaging, Biomedical Optics and Lasers.

Lecture notes
Stored on ILIAS.

Literature
Academic Press

Man-Technology-Environment Electives ("MTU")

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0802-02L</td>
<td>Social Psychology</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>H.D. Daniel, R. Mutz</td>
</tr>
</tbody>
</table>

Abstract
The lecture covers the following main topics: Social perception and interpersonal judgement; attitudes; group dynamics and group performance; leadership behavior and leadership styles.

Objective
The aim of the lecture is to impart a well-founded scientific understanding of social influence processes in individuals, groups, organizations, and social settings.

Content
Im Einzelnen sollen die Teilnehmerinnen und Teilnehmer lernen:
- an den Beispielen von Kaufverhalten oder ökologischem Verhalten zu beschreiben, wie Normen und Einstellungen Einfluss auf das Verhalten nehmen,
- Die Subjektivität und die Fehlerquellen sozialer Wahrnehmung verstehen,
- Prinzipien der Psychologie der Kommunikation zu nutzen für eine Verbesserung der Kommunikation in Studium und Beruf,
- Merkmale und Strukturen von Gruppen zu identifizieren und mit geeigneten Methoden zu analysieren,
- Die Grundlagen von Konformität und Gehorsam gegenüber Autoritäten zu erkennen,
- Gruppenphänomene wie soziales Faulenzein, Risiko- und Konservatismus-Schub und Gruppenendenke entgegenzuwirken,
- Gruppenleistungen und -entscheidungen zu optimieren,
- Führungsstile zu unterscheiden lernen,
- Techniken zur Moderation von interagierenden Gruppen kennen zu lernen.

Lecture notes
kein Skript

Literature

Prerequisites / notice
Es werden für D-ITET-Studierende Gruppenarbeiten (6 Kreditpunkte) in Form eines 3-tätigen computer-unterstützten Assessments fachübergreifender Kompetenzen angeboten (Teilnehmerzahl beschränkt auf 12 Studierende). Die Teilnehmenden verfassen Berichte, die benotet werden.

227-0802-02L Sociology

Abstract
Various studies are used to introduce basic sociological concepts, theories and empirical research methods, along with selected sociological topics. The goal of the course is to provide participants with an understanding of working practice in empirical sociology and the central findings of sociological studies.

Objective
To learn about methods of empirical social research and key results of classic and modern sociological studies.

Content

Folgende Themen werden behandelt:


3. Der Beitrag der Sozialtheorie. Vorstellung und Diskussion ausgewählter Studien zu einzelnen Themenbereichen, z.B.: (1) Die Entstehung sozialer Kooperation, (2) Reputation und Märkte, (3) Soziale Netzwerke u.a.m.


Lecture notes
Foliaren der Vorlesung und weitere Materialien (Fachartikel, Kopien aus Büchern) werden auf der Webseite der Vorlesung zum Download zur Verfügung gestellt.

Literature
Foliaren der Vorlesung und weitere Materialien (Fachartikel, Kopien aus Büchern) werden auf der Webseite der Vorlesung zum Download zur Verfügung gestellt.

Prerequisites / notice
Interesse am Thema und Bereitschaft zum Mitenken.
Abstract

The course explains main principles of air transport in general and elaborates on simple interdisciplinary topics. Since working on broad topics like aerodynamics, manufacturers, airport operation, business aviation, business models etc. the students get a good overview in air Transportation.

Objective

Understand and explain basics, principles and contexts in the broader air transport industry. Lay the foundation of working in or with the air transport industry. Ideal foundation for Aviation II - Management of Air Transport

Content

Weekly: 1h independent preparation; 2h lectures and 1 h training with an expert in the respective field

Concept: This course will be taught as Aviation I. A subsequent course is under evaluation.

Content: Transport as part of the overall transportation scheme; Aerodynamics; Aircraft (A/C) Designs & Structures; A/C Operations; Law Enforcement; Maintenance & Manufacturers; Airport Operations & Planning; Customs & Security; ATC & Airspace; Air Freight; General Aviation; Business Jet Operations; Business models within Airline Industry; Military Operations.

Technical visit: This course includes a guided tour at Zurich Airport (baggage sorting system, apron, ATC Tower).

Examination: written, 60 min, open books (Examination in German; Answers may be given in English)

Lecture notes

Slides are provided prior to each class

Literature

We will also use English papers

Language Courses

see Science in Perspective: Language Courses ETH/UZH
Educational Engineering and Information Technology TC

More informations at: https://www.ethz.ch/de/studium/didaktische-ausbildung/studienangebot-zulassung/didaktik-zertifikat.html

 Educational Science

General course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
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<tr>
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<td>This lecture is only apt for students who intend to enrol in the</td>
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<td>programs &quot;Teaching Diploma&quot; or &quot;Teaching Certificate&quot;. It is about</td>
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<td>learning in childhood and adolescence.</td>
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<td></td>
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<td>This course looks into scientific theories and also empirical</td>
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<td>studies on human learning and relates them to the school.</td>
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<td>Anyone wishing to be a successful teacher must first of all</td>
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<td>understand the learning process. Against this background, theories</td>
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<td>and findings on the way humans process information and on human</td>
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<td>behaviour are prepared in such a manner that they can be used for</td>
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<td>planning and conducting lessons. Students additionally gain an</td>
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<td>understanding of what is going on in learning and behavioural</td>
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<td>research so that teachers are put in a position where they can</td>
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<td>further educate themselves in the field of research into teaching</td>
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<td>and learning.</td>
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<td>Content</td>
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<td>Thematische Schwerpunkte:</td>
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<td>Lernen als Verhaltensänderung und als Informationsverarbeitung:</td>
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<td>Das menschliche Gedächtnis unter besonderer Berücksichtigung der</td>
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<td></td>
<td>Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion</td>
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<td>und Kompetenzwerkzeug unter besonderer Berücksichtigung des</td>
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<td></td>
<td>Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle</td>
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<td></td>
<td>von Emotion und Motivation beim Lernen; Interindividuelle</td>
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<td></td>
<td>Unterschiede in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien, Geschlechtsunterschiede beim Lernen</td>
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<td></td>
<td>Lernformen: Theorien und wissenschaftliche Konstrukte werden</td>
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<td></td>
<td>zusammen mit ausgewählten wissenschaftlichen Untersuchungen in Form</td>
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<td>einer Vorlesung präsentiert. Die Studierenden vertiefen nach jeder</td>
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<td></td>
<td>Stunde die Inhalte durch die Bearbeitung von Aufträgen in einem</td>
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<td></td>
<td>elektronischen Leimtagebuch. Über die Bedeutung des Gelernten für</td>
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<td></td>
<td>den Schulalltag soll reflektiert werden. Ausgewählte Tabelle</td>
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<td></td>
<td>erträge werden zu Beginn jeder Vorlesung thematisiert.</td>
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<tr>
<td>Literature</td>
<td>Folien werden zur Verfügung gestellt.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>This lecture is only apt for students who intend to enrol in the</td>
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<td></td>
<td>programs &quot;Lehrdiplom&quot; or &quot;Didaktisches Zertifikat&quot;. It is about</td>
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<td>learning in childhood and adolescence.</td>
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<tr>
<td>851-0240-03L</td>
<td>Introduction to Test Theory and Test Construction in Educational</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>University lecturers</td>
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<td></td>
<td>Contexts (University of Zurich)</td>
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<td>Enrolment only possible with Teaching Diploma or DC</td>
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<td>matriculation.</td>
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<td>No enrolment to this course at ETH Zurich. Book the corresponding</td>
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<td>module directly at UZH.</td>
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<td>UZH Module Code: 200a968</td>
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<td>Mind the enrolment deadlines at UZH:</td>
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<td><a href="http://www.uzh.ch/studien/application/mobilitaet_en.html">http://www.uzh.ch/studien/application/mobilitaet_en.html</a></td>
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<tr>
<td>Abstract</td>
<td>In this seminar, students establish scientific fundamentals of</td>
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<td></td>
<td>performance measurement and educational diagnostics and study them</td>
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<td>on the basis of different current issues.</td>
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<td>Objective</td>
<td>At the end of the seminar, participants will be in a position to</td>
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<td></td>
<td>- describe the scientific fundamentals of test theory and test</td>
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<td></td>
<td>structure.</td>
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<td>- evaluate examples of scientifically-developed tests in their</td>
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<td>application context.</td>
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<td>- if necessary, critically question the performance assessment that</td>
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<td></td>
<td>they employ in practice and professionalise it still further.</td>
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<tr>
<td>Content</td>
<td>Die konkreten Inhalte des Seminars ergeben sich aufgrund der</td>
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<td></td>
<td>Präferenzen der Teilnehmenden und der daraus abgeleiteten</td>
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<tr>
<td></td>
<td>Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der</td>
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<td></td>
<td>Startveranstaltung wird eine Liste mit möglichen Themen abgegeben</td>
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<td></td>
<td>und erläutert. Schwerpunkte der Themenübersicht sind:</td>
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<td>- Testentwicklung</td>
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<td>- Gütekriterien von Tests</td>
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<td>- Aufgabenkonstruktion</td>
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<td>- Datenauswertung</td>
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<td>- Rasch-Modell</td>
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<td>- Internationale Vergleichstests</td>
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<td>- Zulassungstests</td>
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<tr>
<td>Lecture notes</td>
<td>Im Verlaufe des Semesters werden einzelne Unterlagen in den</td>
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<td></td>
<td>Veranstaltungen abgegeben. Dazu gehören auch die Handouts der</td>
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<td>verschiedenen, studentischen Vorträge.</td>
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<tr>
<td>Literature</td>
<td>Als Grundlagenliteratur werden folgende Werke empfohlen:</td>
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<td>Bern: Huber</td>
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<td></td>
<td>- Weitere Literatur wird in der Lehrveranstaltung genannt.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu</td>
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<td>erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von</td>
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<td>ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen</td>
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<td>dieser Veranstaltung 3 ECTS-Punkte erwerben.</td>
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<td>Dazu sind folgende Leistungen zu erbringen:</td>
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<td></td>
<td>- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)</td>
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<td>- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung</td>
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<td>- Referat (RE)</td>
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<td>- Schreiben einer schriftlichen Arbeit</td>
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<td>Weitere Angaben zu den Leistungsanforderungen werden im Rahmen der</td>
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<td></td>
<td>Startveranstaltung abgegeben und erläutert.</td>
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<tr>
<td>851-0240-16L</td>
<td>Colloquium on the Science of Learning and Instruction</td>
<td>W</td>
<td>1</td>
<td>1K</td>
<td>E. Stern, P. Greutmann,</td>
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<td>further</td>
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<td></td>
<td>Abstract</td>
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<td></td>
<td>In the colloquium we discuss scientific projects concerning the</td>
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<td></td>
<td>teaching in mathematics, computer science, natural sciences and</td>
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<td>technology (STEM). The colloquium is conducted by the professorships</td>
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<td>participating in the Competence Center EducETH (ETH) and in the</td>
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<td>Institute for Educational Sciences (UZH).</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>Participants are exemplary introduced to different research methods</td>
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<td>used in research on learning and instruction and learn to weigh</td>
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<tr>
<td></td>
<td>advantages and disadvantages of these approaches.</td>
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<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4)</td>
<td>W</td>
<td>2</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann,</td>
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</table>

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 506 of 1571
The successful participation in EW1 (“Human Learning”) and EW2 (“Designing Learning Environments for School”) is recommended, but not a mandatory prerequisite.

Abstract

Cognitively Activating Instructions in MINT Subjects

This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.

Objective

- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites / notice

Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

Subject Didactics and Professional Training

Number
Title
Type
ECTS
Hours
Lecturers

151-1061-00L
Subject Didactics I for D-MAVT and D-ITET
O
4 credits
3G
S. P. Kaufmann, J. Dual, M. Thaler

Abstract

Didactical methods in mechanical and electrical engineering.

- The students can plan, conduct and critically reflect single lessons.
- They orient themselves towards the academic goals and take into account existing knowledge, the professional environment and the ambitions of the students.
- They can apply the basic teaching principles meaningfully in their subject and suitably structure the learning phases.
- They can reduce and present complex technical content such that it is in a form suitable for the students to learn.
- They have considered examples of the common conceptual errors encountered by students.

Content

- Didactic analysis
- Competences and goals
- Preparation and wrap-up of lessons
- Process and structure of a typical lesson
- Teaching techniques (informative introduction to lessons, Advance Organizer, learning assignments, frontal teaching, questions, assignments, feedback)
- Assignments and short tests
- Media and language competence
- Conceptual change, misconceptions,
- Integration of the subcomponents of a lesson.

Literature


Prerequisites / notice

Voraussetzung: Erziehungswissenschaftliche Lehrveranstaltung schon absolviert oder gleichzeitig.

227-0853-00L
Mentored Work Subject Didactics Electrical Engineering and Information Technology I
W
2 credits
4A
M. Thaler

Only for students who enrolled before HS 2011 into TC.
### Prerequisites: successful completion of FD I and FD II.

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

### Objective

The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

### Content

- Gemäss aktualisierter Ablaufplanung mit Mentor und Betreuer.
- Das Fachgebiet richtet sich nach dem aktuellen Unterrichtsprogramm des betreuenden FH/BMS-Dozenten.
- Die anzuwendende grössere didakt. Methode ist zum Stoff und Programm passend auszuwählen aus
  - (Mini-)Leitprogramm
  - Gelenktes Entdeckendes Lernen
  - Puzzle
  - Werkstatt
  - Projektarbeit
- Zu diesen Themen sind die vorhandenen Manuals aus den IfV zu verwenden, bzw. wo nötig zu adaptieren.

Die abzuliefernde Bericht hat sich an die dortigen Richtlinien zu halten.

Typisch soll die Arbeit bei Einzelarbeit 2 - 4 Unterrichts-Lektionen abdecken, bei Arbeit zu zweit 4 - 6 solche Einheiten.

### Lecture notes

Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

### Literature

- K. Frey, Allgemeine Didaktik,
- FH-Skript bzw. Lehrbuch des Praktikumslehrers.

### Prerequisites / notice

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
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<tbody>
<tr>
<td>Teaching Internship Including Examination Lessons Electrical Engineering and Information Technology</td>
</tr>
<tr>
<td>Only for students who enrolled before HS 2011 into TC.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>227-0859-00L</th>
<th>Teaching Internship Including Examination Lessons Electrical Engineering and Information Technology</th>
<th>4 credits</th>
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<tbody>
<tr>
<td>W</td>
<td>M. Thaler</td>
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</tbody>
</table>

**Abstract**

Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as as examined as Examination Lessons.

**Objective**

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They try to find the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

**Content**

- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.
- They learn to assess pupils’ work.
- They learn to assess pupils’ work.
- They learn to assess pupils’ work.

**Lecture notes**

- Dokument: schriftliche Vorbereitung für Prüfungslektionen.

<table>
<thead>
<tr>
<th>Lecture notes</th>
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<tbody>
<tr>
<td>Teaching Internship Including Examination Lessons Electrical Engineering and Information Technology</td>
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<tr>
<td>Only for students who enrolled from HS 2011 on into TC.</td>
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</table>

<table>
<thead>
<tr>
<th>227-0859-10L</th>
<th>Teaching Internship Including Examination Lessons Electrical Engineering and Information Technology</th>
<th>6 credits</th>
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<tr>
<td>W</td>
<td>M. Thaler</td>
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</table>

**Abstract**

The teaching internship can only be visited if all other courses of TC have been completed. Repetition of the teaching internship is no possible, also if the examination lessons have to be repeated.

**Objective**

- Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as as examined as Examination Lessons.
- To show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.
- They learn the skills of the teaching trade.
- They try to find the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäß Anleitung und reichen sie bis am Vortag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

**Further Subject Didactics**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0854-00L</td>
<td>Mentored Work Subject Didactics Electrical Engineering and Information Technology II</td>
<td>O</td>
<td>2 credits</td>
<td>4A</td>
<td>M. Thaler</td>
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</tbody>
</table>

**Abstract**
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**

Der abzuliefernde Bericht hat sich an die Richtlinien der vorhandenen Manuals aus den IfV zu halten. Er ist in zwei Teilen zu erstellen, für Studenten/(Benützer), und für den Dozenten/(Entwickler) getrennt.

Typisch soll die Arbeit 3 - 4 Unterrichts-Einheiten à 45 Minuten abdecken (bei Einzelarbeit), bei Arbeit zu zwei mindestens 6 solche Einheiten.

Die Einsatzziele ist wenn möglich durch Erprobung, zu überprüfen.

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Die Arbeit wurde vor Beginn des Praktikums abgeschlossen werden.

**Electrical Engineering and Information Technology TC - Key for Type**

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<tr>
<th>O</th>
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<th>W</th>
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<th>Z</th>
<th>Dr</th>
<th>ECTs</th>
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<tr>
<td>Compulsory</td>
<td>Eligible for credits and recommended</td>
<td>Eligible for credits</td>
<td>Recommended, not eligible for credits</td>
<td>Courses outside the curriculum</td>
<td>Suitable for doctorate</td>
<td>European Credit Transfer and Accumulation System</td>
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**Key for Hours**

<table>
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<th>V</th>
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<tbody>
<tr>
<td>lecture</td>
<td>lecture with exercise</td>
<td>exercise</td>
<td>seminar</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>A</td>
<td>D</td>
<td>R</td>
<td>ECTs</td>
</tr>
<tr>
<td>practical/laboratory course</td>
<td>independent project</td>
<td>diploma thesis</td>
<td>revision course / private study</td>
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</tbody>
</table>

Special students and auditors need special permission from the lecturers.
The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI projects round off the course. 

The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning. The fundamentals of Information Theory including Shannon’s source coding and channel coding theorems.

Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense. This second course in our VLSI series is concerned with how to turn digital circuit netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects. Low-power circuit design is another important topic. Economic aspects and management issues of VLSI projects round off the course.

#### 227-0147-00L VLSI II: Design of Very Large Scale Integration Circuits

**Abstract**
This second course in our VLSI series is concerned with how to turn digital circuit netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects. Low-power circuit design is another important topic. Economic aspects and management issues of VLSI projects round off the course.

**Objective**
Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.

**Content**
The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI. Topics include:
- The difficulties of finding fabrication defects in large VLSI chips.
- How to make integrated circuit testable (design for test).
- Synchronous clocking disciplines compared, clock skew, clock distribution, input/output timing.
- Synchronization and metastability.
- CMOS transistor-level circuits of gates, flip-flops and random access memories.
- Sinks of energy in CMOS circuits.
- Power estimation and low-power design.
- Current research in low-energy computing.
- Layout parasitics, interconneted delay, static timing analysis.
- Switching currents, ground bounce, IR-drop, power distribution.
- Floorplanning, chip assembly, packaging.
- Layout design at the mask level, physical design verification.
- Electromigration, electrostatic discharge, and latch-up.
- Models of industrial cooperation in microelectronics.
- The caveats of virtual components.
- The cost structures of ASIC development and manufacturing.
- Market requirements, decision criteria, and case studies.
- Yield models.
- Avenues to low-volume fabrication.
- Marketing considerations and case studies.
- Management of VLSI projects.

Exercises are concerned with back-end design (floorplanning, placement, routing, clock and power distribution, layout verification). Industrial CAD tools are being used.

**Lecture notes**

**Literature**
All written documents in English.

**Prerequisites / notice**

Highlight:
Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.

Prerequisites:
“VLSI I: from Architectures to Very Large Scale Integration Circuits and FPGAs” or equivalent knowledge.

Further details:
http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html

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**227-0417-00L Information Theory I**

**Abstract**
This course covers the basic concepts of information theory and of communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.

**Objective**
The entropy rate of a source. Typical sequences, the asymptotic equi-partition property, the source coding theorem, Huffman coding, Arithmetic coding, channel capacity, the channel coding theorem, the source-channel separation theorem, feedback capacity

**Content**
- The fundamentals of Information Theory including Shannon's source coding and channel coding theorems
- The entropy rate of a source, Typical sequences, the asymptotic equi-partition property, the source coding theorem, Huffman coding, Arithmetic coding, channel capacity, the channel coding theorem, the source-channel separation theorem, feedback capacity

**Literature**
T.M. Cover and J. Thomas, Elements of Information Theory (second edition)

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**227-0427-00L Signal and Information Processing: Modeling, Filtering, Learning**

**Abstract**

**Objective**
The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

**Content**


**Lecture notes**
Lecture notes.

**Prerequisites / notice**
- local bachelors: course "Discrete-Time and Statistical Signal Processing" (5. Sem.)
- others: solid basics in linear algebra and probability theory

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**227-0439-00L Wireless Access Systems**

**Abstract**
- Passive and active components for wireless access systems.
- Antennas and propagation.
- Small cells and macrocells.
- Wireless local area networks.
- Mobile communication.
- Satellite communication.

**Objective**
Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.

Prerequisites:
“VLSI I: from Architectures to Very Large Scale Integration Circuits and FPGAs” or equivalent knowledge.

Further details:
http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html

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**Notice**
All written documents in English.

**Prerequisites / notice**

Highlight:
Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.

Prerequisites:
“VLSI I: from Architectures to Very Large Scale Integration Circuits and FPGAs” or equivalent knowledge.

Further details:
http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html
Abstract
Wireless access systems support locally constrained wireless connectivity and mobile access to a backbone network (typically the Internet). In this course the student develops a comprehensive understanding of existing and upcoming wireless access technologies (including WiFi, Bluetooth, RFID, NFC, VANET) and related Physical Layer and Medium Access Control Layer problems and opportunities.

Objective
The course consists of two tracks. The track “Technology&Systems” is structured as regular lecture. In the introduction we will discuss the challenges and potential of pervasive wireless access and study some fundamentals of short/medium range wireless communications. The main body of this track is devoted to existing and upcoming systems. A comprehensive survey of Ultrawide band (UWB) as the promising transmission technology for pervasive wireless access completes this track. In the track “Simulate&Practice” we form student teams that implement and analyze functional blocks of the physical layer of various advanced wireless access systems based on MATLAB simulations. The track includes combination tasks where different teams combine their functional blocks (e.g. transmitter, receiver) in order to simulate the complete physical layer.

Content
1. Short range wireless communication: fundamental Physical Layer challenges and solutions
2. Wireless Local Area Network (WLAN)
3. Vehicular Networks (VANET)
4. Ultra-Wideband (UWB) technology: fundamental principles, promises and solutions
5. Wireless Body Area Networks (WBAN)
6. Wireless Personal Area Networks (Bluetooth, Zigbee)
7. Radio Frequency Identification (RFID) and Near Field Communication (NFC)

Lecture notes
Lecture Slides and handouts.

Prerequisites / notice
Requirements: Knowledge of fundamental principles of digital communication systems (e.g. 227-0121-00 G Kommunikationssysteme) is helpful but not mandatory. Lecture is given in English.
Objective

Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Content


Literature


Prerequisites / notice

Prerequisites: Signal and Systems Theory II.

MATLAB is used for system analysis and simulation.

227-0112-00L High-Speed Signal Propagation

Understanding of high-speed signal propagation in microwave cables and printed circuit boards.

As clock frequencies rise in the GHz domain, there is a need grasp signal propagation to maintain good signal integrity in the face of symbol interference and cross-talk.

Objective

The course is of high value to all interested in high-speed analog (RF, microwave) or digital systems.

Understanding of high-speed signal propagation in interconnects, microwave cables and integrated transmission lines such as microwave integrated circuits and/or printed circuit boards.

As system clock frequencies continuously rise in the GHz domain, a need urgently develops to understand high-speed signal propagation in order to maintain good signal integrity in the face of phenomena such as inter-symbol interference (ISI) and cross-talk.

Content

Concepts such as Scattering parameters (or S-parameters) are key to the characterization of networks over wide bandwidths. At high frequencies, all structures effectively become "transmission lines." Unless care is taken, it is highly probable that one ends up with a bad transmission line that causes the designed system to malfunction.

Filters will also be considered because it turns out that some of the problems associated by lossy transmission channels (lines, cables, etc) can be corrected by adequate filtering in a process called "equalization."


Lecture notes

Script: Leitungen und Filter (In German).

Exercises will be held in German, but assistants also speak English.

227-0166-00L Analog Integrated Circuits

This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.

Objective

Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems.

The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.

Content

Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems.

The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.

Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits.

The exercise sessions aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is used to facilitate the tasks. There is also an experimental session on op-amp measurements.

Lecture notes

Handouts of presented slides. No script but an accompanying textbook is recommended.

Literature


15 credits

227-0301-00L Optical Communication Fundamentals

The path of an analog signal in the transmitter to the digital world in a communication link and back to the analog world at the receiver is discussed. The lecture covers the fundamentals of all important optical and optoelectronic components in a fiber communication system. This includes the transmitter, the fiber channel and the receiver with the electronic digital signal processing elements. The important elements will be passed on. Students attending the lecture will further get engaged in critical discussion on societal, economical and environmental aspects related to the on-going exponential growth in the field of communications.

Content

* Chapter 1: Introduction: Analog/Digital conversion, The communication channel, Shannon channel capacity, Capacity requirements.


* Chapter 4: The Receiver: Photodiodes, Receiver noise, Detector schemes (direct detection, coherent detection), Bit-error ratios and error estimations.

* Chapter 5: Digital Signal Processing Techniques: Digital signal processing in a coherent receiver, Error detection techniques, Error correction coding.

* Chapter 6: Pulse Shaping and Multiplexing Techniques: WDM/FDM, TDM, OFDM, Nyquist Multiplexing, OCDMA.

* Chapter 7: Optical Amplifiers : Semiconductor Optical Amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers.

MATLAB is used for system analysis and simulation.
Introduction to the degradation and failure mechanisms and causes of electronic components, devices, and systems as well as to methods and tools of reliability testing, characterization, and failure analysis.

Abstract
Failures have to be avoided by proper design, material selection, and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

Objective
Introduction to the degradation and failure mechanisms and causes of electronic components, devices, and systems as well as to methods and tools of reliability testing, characterization, and failure analysis.

Content
Summary of reliability and failure analysis terminology; physics of failures: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis.

Lecture notes
Comprehensive copy of transparencies

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227-0377-00L
Title: Physics of Failure and Failure Analysis of Electronic Devices and Equipment

Abstract
Failures have to be avoided by proper design, material selection, and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

Objective
Introduction to the degradation and failure mechanisms and causes of electronic components, devices, and systems as well as to methods and tools of reliability testing, characterization, and failure analysis.

Content
Summary of reliability and failure analysis terminology; physics of failures: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis.

Lecture notes
Comprehensive copy of transparencies

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227-0447-00L
Title: Image Analysis and Computer Vision

Abstract

Objective
Overview of the most important concepts of image formation, perception, and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions

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227-0455-00L
Title: Terahertz: Technology & Applications

Abstract
This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting.

Objective
This is an introductory course on Terahertz (THz) technology and applications. Devices operating in THz frequency range (0.1 to 10 THz) have been increasingly studied in the recent years. Progress in nonlinear optical materials, ultrafast optical and electronic techniques has strengthened research in THz application developments. Due to unique interaction of THz waves with materials, applications with new capabilities can be developed. In theory, they can penetrate somewhat like X-rays, but are not considered harmful radiation, because THz energy level is low. They should be able to provide resolution as good or better than magnetic resonance imaging (MRI), possibly with simpler equipment. Imaging, very-high bandwidth communication, and energy harvesting are the most widely explored THz application areas. We will study the basics of THz generation, manipulation, and detection. Our emphasis will be on the physical principles and applications of THz in the domain of imaging, communication, and energy harvesting.

Content
INTRODUCTION
Chapter 1: Introduction to THz Physics
Chapter 2: Components of THz Technology

THz TECHNOLOGY MODULES
Chapter 3: THz Generation
Chapter 4: THz Detection
Chapter 5: THz Manipulation

APPLICATIONS
Chapter 6: THz Imaging
Chapter 7: THz Communication
Chapter 8: THz Energy Harvesting

- Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009

Whenever we deviate from the main material discussed in these books, softcopy of lectures notes will be provided.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions

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227-0468-00L
Title: Analog Signal Processing and Filtering

Abstract
Suitable for Master Students as well as Doctoral Students. This lecture provides a wide overview over analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers.

Objective
This lecture provides a wide overview over analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers. The way the exam is done allows for the different interests of the two groups.

The learning goal is that the students can apply signal-flow graphs and can understand the signal flow in such circuits and systems (including non-ideal effects) well enough to gain an understanding of further circuits and systems by themselves.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions

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At the beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during the whole term to analyze circuits and understand how signals propagate through them. The theory and CMOS implementation of active filters is then discussed in detail using the example of Gm-C filters and active-RC filters. The ideal and nonideal behaviour of opamps, current conveyors, and inductor simulators follows. The link to the practical design of circuits and systems is done with an overview over different quality measures and figures of merit used in scientific literature and datasheets. Finally, an introduction to discrete-time and mixed-domain filters and circuits is given, including sensor read-out amplifiers, correlated double sampling, and chopping, and an introduction to sigma-delta A/D and D/A conversion on a system level.

The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware/Software Codesign (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures, System-on-Chip), (c) Application specific instruction sets, code generation and retargetable compilation, (d) Performance analysis and estimation techniques, (e) System design (hardware-software partitioning and design space exploration).

This course is accompanied by practical machine learning projects.

Prerequisites for the course is a basic knowledge in the following areas: computer architecture, digital design, software design, embedded systems.

### 227-0477-00L Acoustics I

**Abstract**
Introduction to the fundamentals of acoustics in the area of sound field calculations, measurement of acoustical events, outdoor sound propagation and room acoustics of large and small enclosures.

**Objective**
Introduction to acoustics. Understanding of basic acoustical mechanisms. Survey of the technical literature. Illustration of measurement techniques in the laboratory.

**Content**
Fundamentals of acoustics, measuring and analyzing of acoustical events, anatomy and properties of the ear. Outdoor sound propagation, absorption and transmission of sound, room acoustics of large and small enclosures, architectural acoustics, noise and noise control, calculation of sound fields.

**Literature**

**Prerequisites / notice**
Knowledge of the Laplace transform and z transform and their interpretation (transfer functions, poles and zeros, bode diagrams, stability criteria ...) and of the main properties of linear systems is necessary.

### 227-0778-00L Hardware/Software Codesign

**Abstract**
The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.

**Objective**
The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.

**Content**
The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware-Software Interfaces (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures, System-on-Chip), (c) Application specific instruction sets, code generation and retargetable compilation, (d) Performance analysis and estimation techniques, (e) System design (hardware-software partitioning and design space exploration).

**Lecture notes**
Material for exercises, copies of transparencies.

**Prerequisites / notice**
Prerequisites for the course is a basic knowledge in the following areas: computer architecture, digital design, software design, embedded systems.

### 252-0535-00L Machine Learning

**Abstract**
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

**Objective**
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

**Content**
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

**Topics covered in the lecture include:**
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

**Prerequisites / notice**
The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

**Lecture notes**
No lecture notes, but slides will be made available on the course webpage.

**Literature**


**Prerequisites / notice**
The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.
A detailed reading list will be made available in the lecture.

S. Capkun
Knowledge of the state-of-the-art in low power system design, understanding recent research results and their implication on industrial applications.

Type
Designing systems with a low energy footprint is an increasingly important. There are many applications for low-power systems ranging from mobile devices powered from batteries such as today’s smart phones to energy efficient household appliances and datacenters. Key drivers are to be found mainly in the tremendous increase of mobile devices and the growing integration density requiring to carefully reason about power, both from a provision and consumption viewpoint. Traditional circuit design classes introduce low-power solely from a hardware perspective with a focus on the power performance of a single or at most a hand full of circuit elements. Similarly, low-power aspects are touched in a multitude of other classes, mostly as a side topic. However in successfully designing systems with a low energy footprint it is not sufficient to only look at low-power as an aspect of second class. In modern low-power system design advanced CMOS circuits are of course a key ingredient but successful low-power integration involves many more disciplines such as system architecture, different sources of energy as well as storage and most importantly software and algorithms. In this lecture we will discuss aspects of low-power design as a first class citizen introducing key concepts as well as modeling and measurement techniques focusing mainly on the different sources of energy as well as storage and most importantly software and algorithms.

Content
Risk management and the vulnerability lifecycle of software and networked services are discussed. Threats like denial of service, spam, worms, and viruses are studied in-depth. Fundamental security related concepts like identity, availability, authentication and secure channels are introduced. State of the art technologies like secure shell, network and transport layer security, intrusion detection and prevention systems, cross-site scripting, secure implementation techniques and more for securing the Internet and web applications are presented. Several case studies illustrate the dark side of the Internet and explain how to protect against current threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

This lecture is intended for students with an interest in securing Internet services and networked devices. Students are assumed to have knowledge in networking as taught in the Communication Networks lecture.

Prerequisites / notice
Knowledge of computer networking and Internet protocols (e.g. course Communication Networks (D-ITET) or Operating Systems and Networks (D-INFK)).

Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.

Computers and Networks
Core Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0778-00L</td>
<td>Hardware/Software Codesign</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U</td>
<td>L. Thiele</td>
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<tr>
<td>Abstract</td>
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<tr>
<td>Lecture notes</td>
<td>Material for exercises, copies of transparencies.</td>
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| 227-0781-00L | Low-Power System Design  | W    | 6 credits | 2V+2U | J. Beutel |
| Abstract | Introduction to low-power and low-energy design techniques from a systems perspective including aspects both from hard- and software. The focus of this lecture is on cutting across a number of related fields discussing architectural concepts, modeling and measurement techniques as well as software design mainly using the example of networked embedded systems. |
| Objective | Knowledge of the state-of-the-art in low power system design, understanding recent research results and their implication on industrial products. |
| Content  | Designing systems with a low energy footprint is an increasingly important. There are many applications for low-power systems ranging from mobile devices powered from batteries such as today’s smart phones to energy efficient household appliances and datacenters. Key drivers are to be found mainly in the tremendous increase of mobile devices and the growing integration density requiring to carefully reason about power, both from a provision and consumption viewpoint. Traditional circuit design classes introduce low-power solely from a hardware perspective with a focus on the power performance of a single or at most a hand full of circuit elements. Similarly, low-power aspects are touched in a multitude of other classes, mostly as a side topic. However in successfully designing systems with a low energy footprint it is not sufficient to only look at low-power as an aspect of second class. In modern low-power system design advanced CMOS circuits are of course a key ingredient but successful low-power integration involves many more disciplines such as system architecture, different sources of energy as well as storage and most importantly software and algorithms. In this lecture we will discuss aspects of low-power design as a first class citizen introducing key concepts as well as modeling and measurement techniques focusing mainly on the design of networked embedded systems but of course equally applicable to many other classes of systems. The lecture is further accompanied by a reading seminar as well as exercises and lab sessions. |
| Lecture notes | Exercise and lab materials, copies of lecture slides. |
| Literature | A detailed reading list will be made available in the lecture. |
| Prerequisites / notice | Knowledge in embedded systems, system software, (wireless) networking, possibly integrated circuits, and hardware software codeign. |

| 252-1414-00L | System Security  | W    | 5 credits | 2V+2U | S. Capkun, A. Perrig |
| Abstract | The first part of the lecture covers individual system aspects starting with tamperproof or tamper-resistant hardware in general over operating system related security mechanisms to application software systems, such as host based intrusion detection systems. In the second part, the focus is on system design and methodologies for building secure systems. |
| Objective | In this lecture, students learn about the security requirements and capabilities that are expected from modern hardware, operating systems, and other software environments. An overview of available technologies, algorithms and standards is given, with which these requirements can be met. |
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear systems and filters. The two parts of the course cover individual system's aspects starting with tamperproof or tamperresistant hardware in general over process automation, concept of control. Modelling of dynamical systems - examples, state space description, linearisation, observer canonical form), state feedback, pole placement - choice of poles. Observer, observability, duality, separation principle. LQ Array, decoupling, sensitivity to model uncertainty. State space representation (modal description, controllability, control canonical form, stable realizations and robust inversion.

In the second part, the focus is on system design and methodologies for building secure systems. Topics include: patch management, common software faults (buffer overflows, etc.), writing secure software (design, architecture, QA, testing), compiler-supported security, language-supported security, logging and auditing (BSM audit, dtrace, ...), cryptographic support, and trustworthy computing (TGG, SGX).

Along the lectures, model cases will be elaborated and evaluated in the exercises.

#### Recommended Subjects

These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>227-0101-00L</td>
<td>Discrete-Time and Statistical Signal Processing</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>H.A. Loeliger</td>
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<tr>
<td>227-0103-00L</td>
<td>Control Systems</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U</td>
<td>F. Dörfler</td>
</tr>
<tr>
<td>227-0197-00L</td>
<td>Wearable Systems I</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>G. Tröster, U. Blanke</td>
</tr>
</tbody>
</table>

- **Abstract**: The course introduces fundamental concepts and technologies in the area of network security. Several case studies illustrate the dark side of the Internet and explain how to protect against such threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection. Students are aware of current threats that Internet services and networked devices face and can explain appropriate countermeasures. Students can identify and assess known vulnerabilities in a software system that is connected to the Internet. Students know fundamental network security concepts. Students have an in-depth understanding of important security technologies. Students know how to configure a real firewall and know some penetration testing tools from their own experience.

- **Content**: Risk management and the vulnerability lifecycle of software and networked services are discussed. Threats like denial of service, spam, worms, and viruses are studied in-depth. Fundamental security related concepts like identity, availability, authentication and secure channels are introduced. State of the art technologies like secure shell, network and transport layer security, intrusion detection and prevention systems, cross-site scripting, secure implementation techniques and more for securing the Internet and web applications are presented. Several case studies illustrate the dark side of the Internet and explain how to protect against current threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection. This lecture is intended for students with an interest in securing Internet services and networked devices. Students are assumed to have knowledge in networking as taught in the Communication Networks lecture.

- **Prerequisites / notice**: Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.
Abstract
Context recognition in mobile communication systems like mobile phone, smart watches and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning.

Context comprises the behavior of individuals and of groups, their activities as well as the local and social environment.

Objective
Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our 'smart phone' detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our 'smart phone' offers us the appropriate services like a personal assistant. Context comprises user's behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

Context recognition as the crucial function of mobile systems is the main focus of the course. Using MATLAB the participants implement and verify the discussed methods also using a smart phone.

Content
Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our 'smart phone' detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our 'smart phone' offers us the appropriate services like a personal assistant. Context recognition - what is the situation of the user, his activity, his environment, how is he doing, what are his needs - as the central functionality of mobile systems constitutes the focus of the course.

The main topics of the course include
- Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarly measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, KNN-Methods, Support Vector Machine, AdaBoost, Deep Learning), clustering (k-means, dbscan, topic models), Recommender Systems, Collaborative Filtering, Crowdsourcing.

The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and localization of the local environment.

Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

Language: german/english (depending on the participants)

Lecture notes
Lecture notes for all lessons, assignments and solutions.
http://www.ife.ee.ethz.ch/education/wearable_systems_1

Literature
Literature will be announced during the lessons.

Prerequisites / notice
No special prerequisites

227-0377-00L Physics of Failure and Failure Analysis of Electronic Devices and Equipment W 3 credits 2V U. Sennhauser

Abstract
Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

Objective
Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.

Content
Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis.

Lecture notes
Comprehensive copy of transparencies

252-0437-00L Distributed Algorithms W 4 credits 3V F. Mattern

Abstract
Models of distributed computations, time space diagrams, virtual time, logical clocks and causality, wave algorithms, parallel and distributed graph traversal, consistent snapshots, mutual exclusion, election and symmetry breaking, distributed termination detection, garbage collection in distributed systems, monitoring distributed systems, global predicates.

Objective
Become acquainted with models and algorithms for distributed systems.

Content
Verteilte Algorithmen sind Verfahren, die dadurch charakterisiert sind, dass mehrere autonome Prozesse gleichzeitig Teile eines gemeinsamen Problems in kooperativer Weise bearbeiten und der dabei erforderliche Informationsaustausch ausschliesslich über Nachrichten erfolgt. Derartige Algorithmen kommen im Rahmen verteilter Systeme zum Einsatz, bei denen kein gemeinsamer Speicher existiert und die Übertragungszeit von Nachrichten i.a. nicht vernachlässigt werden kann. Da dabei kein Prozess eine aktuelle konsistente Sicht des globalen Zustands besitzt, führt dies zu interessanten Problemen. Im einzelnen werden u.a. folgende Themen behandelt:
- Modelle verteilter Berechnungen; Raum-Zeit-Diagramme; Virtuelle Zeit; Logische Uhren und Kausalität; Wellenalgorithmen; Verteilte und parallele Graphtraversierung; Berechnung konsistenter Schnappschüsse; Wechselseitiger Ausschluss; Election und Symmetriebrechung; Verteilte Terminierung; Garbage-Collection in verteilter Systemen; Beobachten verteilter Systeme; Berechnung globaler Prädikate.

Literature
- F. Mattern: Verteilte Algorithmen, Springer-Verlag
- G. Tel: Topics in Distributed Algorithms, Cambridge University Press
- G. Tel: Introduction to Distributed Algorithms, Cambridge University Press, 2nd edition
- N. Lynch: Distributed Algorithms, Morgan Kaufmann Publ

227-0447-00L Image Analysis and Computer Vision W 6 credits 3V+1U L. Van Gool, O. Göksel, E. Konukoglu

Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.
Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination source are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Prerequisites / notice
Course material Script, computer demonstrations, exercises and problem solutions
Basics of computer architecture.

Lecture notes
Script and exercises sheets.

227-0555-00L Fault Tolerance in Distributed Systems
Objective
Become acquainted with pertinent technologies and architectures of fault-tolerant distributed systems.

Content
We discuss fault-tolerance issues (models, consensus, agreement) as well as replication issues (primary copy, 2PC, 3PC, Paxos, quorum systems, distributed storage) and problems with asynchronous multiprocessors (shared memory, spin locks, concurrency).

227-0627-00L Applied Computer Architecture
Objective
Understand the function, the design and the performance modeling of parallel computer systems.

Content
The lecture "Applied Computer Architecture" gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits.

227-0593-00L Embedded Control Systems
Objective
Familiarize students with main architectural principles and concepts of embedded control systems.

Content
An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch.

Lecture notes
Lecture notes, lab instructions, supplemental material

Prerequisite courses are Control Systems I and Informatics I.

252-1411-00L Security of Wireless Networks
Objective
After this course, the students should be able to describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc/sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.

Content
In the last two decades, we have experienced an unprecedented growth in the area of distributed systems and networks; distributed computing now encompasses many of the activities occurring in today's computer and communications world. This course introduces the basics of distributed computing, highlighting common themes and techniques. We study the fundamental issues underlying the design of distributed systems: communication, coordination, synchronization, uncertainty. We explore essential algorithmic ideas and lower bound techniques.

In this seminar, students present the latest work in this domain.

**Objective**

- Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.
- How to manage industrial VLSI projects, including the management of VLSI projects and design.
- Abstract and content
- Literature
- Prerequisites

**Content**

- Different each year. For details see: www.disco.ethz.ch/courses.html
- Slides of presentations will be made available.
- The actual paper selection can be found on www.disco.ethz.ch/courses.html.

**Core Subjects**

These core subjects are particularly recommended for the field of "Electronics and Photonics".

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
227-0147-00L | VLSI II: Design of Very Large Scale Integration Circuits | W | 7 credits | 5G | H. Kaeslin, F. K. Gürkaynak, M. Korb

**Abstract**

This second course in our VLSI series is concerned with how to turn digital circuit netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects. Low-power circuit design is another important topic. Economic aspects and management issues of VLSI projects round off the course.

**Objective**

- Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.

**Content**

- The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI. Topics include:
  - The difficulties of finding fabrication defects in large VLSI chips.
  - How to make integrated circuit testable (design for test).
  - Synchronous timing disciplines compared, clock skew, clock distribution, input/output timing.
  - Synchronization and metastability.
  - CMOS transistor-level circuits of gates, flip-flops and random access memories.
  - Sinks of energy in CMOS circuits.
  - Power estimation and low-power design.
  - Current research in low-energy computing.
  - Layout parasitics, interconnected delay, static timing analysis.
  - Electromigration, electrostatic discharge, and latch-up.
  - Models of industrial cooperation in microelectronics.
  - The caveats of virtual components.
  - The cost structures of ASIC development and manufacturing.
  - Market requirements, decision criteria, and case studies.
  - Yield models.
  - Avenues to low-volume fabrication.
  - Marketing considerations and case studies.
  - Management of VLSI projects.

Exercises are concerned with back-end design (floorplanning, placement, routing, clock and power distribution, layout verification). Industrial CAD tools are being used.

**Lecture notes**


**Literature**

All written documents in English.


**Prerequisites / notice**

Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.

**Highlight:**

"VLSI I: from Architectures to Very Large Scale Integration Circuits and FPGAs" or equivalent knowledge.

Further details:

http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
227-0197-00L | Wearable Systems | W | 6 credits | 4G | G. Tröster, U. Blanke

**Abstract**

Context recognition in mobile communication systems like mobile phone, smart watches and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning.

**Objective**

- Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our 'smart phone' detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our 'smart phone' offers us the appropriate services like a personal assistant.
- Context comprises user's behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

Context recognition as the crucial function of mobile systems is the main focus of the course. Using MatLab the participants implement and verify the discussed methods also using a smart phone.
Nano-Optics is the study of optical phenomena and techniques on the nanometer scale. It is an emerging field of study motivated by the rapid advance of nanoscience and technology. It embraces topics such as plasmonics, optical antennas, optical trapping and manipulation, and high-resolution imaging and spectroscopy. The main topics of the course include:

### Chapter 1: Introduction
- Analog/Digital conversion
- The communication channel
- Shannon channel capacity
- Capacity requirements

The path of an analog signal in the transmitter to the digital world in a communication link and back to the analog world at the receiver is discussed. The lecture covers the fundamentals of all important optical and optoelectronic components in a fiber communication system. This includes the transmitter, the fiber channel and the receiver with the electronic digital signal processing elements.

### Chapter 2: The Transmitter
- Components of a transmitter
- Lasers
- The spectrum of a signal
- Optical modulators
- Modulation formats

Starting with an angular spectrum representation of optical fields the role of inhomogeneous evanescent fields is discussed. Among the important elements will be passed on. Students attending the lecture will further get engaged in critical discussion on societal, economical and environmental aspects related to the on-going exponential growth in the field of communications.

### Chapter 3: The Optical Fiber Channel
- Geometrical optics
- The wave equations in a fiber
- Fiber modes
- Fiber propagation
- Fiber losses
- Nonlinear effects in a fiber

The next lecture introduces the topics of emitter sources and fiber communication. The importance of the fiber will be discussed in detail. The receiver will be dealt with in the last chapter.

### Chapter 4: The Receiver
- Photodiodes
- Receiver noise
- Detector schemes
- Bit-error ratios
- Error detection techniques

Understanding of the characteristics of neuromorphic circuit elements.

### Chapter 5: Digital Signal Processing Techniques
- Digital signal processing in a coherent receiver
- Error detection techniques
- Error correction coding

This includes the transmitter, the fiber channel and the receiver with the electronic digital signal processing elements.

### Chapter 6: Pulse Shaping and Multiplexing Techniques
- WDM/FDM
- TDM
- Nyquist Multiplexing
- OCDMA

The next lecture introduces the topics of emitter sources and fiber communication. The importance of the fiber will be discussed in detail. The receiver will be dealt with in the last chapter.

### Literature

### Prerequisites / Notice
- No special prerequisites

### Assessment
- Lecture notes are handed out.
- An in-depth understanding on how information is transmitted from source to destination. Also the mathematical framework to describe the transmission of information is discussed.

The course covers devices in CMOS technology (MOS transistor below threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions.

### Content
- The course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

### Objective
- Understanding of the characteristics of neuromorphic circuit elements.

### Content
- Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions.

### Literature
This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks

Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current

Analog Integrated Circuits


Semiconductor Devices: Physical Bases and

Introduction into the fundamentals of digital communication systems. Selected examples on the application of the fundamental principles in existing and upcoming communication systems

The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model,

Information Theory, Signal Space Analysis, Baseband Transmission, Passband Transmission, Example und Channel, Data Link Layer,

The course addresses the physical principles of modern semiconductor devices, the foundations of the physical modeling of transport and its numerical simulation. During the course also basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.

The application of the basic methods will be extensively explained using existing and future wireless and wired systems.


The script (in book style) is sufficient. Further reading will be recommended in the lecture.


This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.

These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
227-0121-00L | Communication Systems | W | 6 | 4G | A. Wittneben
Abstract | Information Theory, Signal Space Analysis, Baseband Transmission, Passband Transmission, Example und Channel, Data Link Layer, MAC, Example Layer 2, Layer 3, Internet
Objective | Introduction into the fundamentals of digital communication systems. Selected examples on the application of the fundamental principles in existing and upcoming communication systems
Content | Covered are the lower three layer of the OSI reference model: the physical, the data link, and the network layer. The basic terms of information theory are introduced. After this, we focus on the methods for the point to point communication, which may be addressed elegantly and coherently in the signal space. Methods for error detection and correction as well as protocols for the retransmission of perturbed data will be covered. Also the medium access for systems with shared medium will be discussed. Finally, algorithms for routing and flow control will be treated.

Lecture notes

Literature

227-0157-00L | Semiconductor Devices: Physical Bases and Simulation | W | 4 | 3G | A. Schenk
Abstract | The course addresses the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation. Necessary basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.
Objective | The course aims at the understanding of the principle physics of modern semiconductor devices, of the foundations in the physical modeling of transport and its numerical simulation. During the course also basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.
Content | The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model, hydrodynamic model), physical characterization of silicon (intrinsics properties, scattering processes), mobility of cold and hot carriers, recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions.

The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.


The script (in book style) is sufficient. Further reading will be recommended in the lecture.


227-0166-00L | Analog Integrated Circuits | W | 6 | 2V+2U | Q. Huang
Abstract | This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.
Objective | Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems.

The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.

Content | Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits.

The exercise sessions aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is used to facilitate the tasks. There is also an experimental session on op-amp measurements.

Lecture notes

Literature

227-0377-00L | Physics of Failure and Failure Analysis of Electronic Devices and Equipment | W | 3 | 2V | U. Sennhauser
Abstract | Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

Objective | Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.

Content | Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis

Lecture notes

227-0455-00L | Terahertz: Technology & Applications | W | 3 | 2V | K. Sankaran
Abstract | This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting.
This is an introductory course on Terahertz (THz) technology and applications. Devices operating in THz frequency range (0.1 to 10 THz) have been increasingly studied in the recent years. Progress in nonlinear optical materials, ultrafast optical and electronic techniques has strengthened research in THz application developments. Due to unique interaction of THz waves with materials, applications with new capabilities can be developed. In theory, they can penetrate somewhat like X-rays, but are not considered harmful radiation, because THz energy level is low. They should be able to provide resolution as good or better than magnetic resonance imaging (MRI), possibly with simpler equipment. Imaging, very-high bandwidth communication, and energy harvesting are the most widely explored THz application areas. We will study the basics of THz generation, manipulation, and detection. Our emphasis will be on the physical principles and applications of THz in the domain of imaging, communication and energy harvesting.

### Content

**INTRODUCTION**

Chapter 1: Introduction to THz Physics

Chapter 2: Components of THz Technology

**THz TECHNOLOGY MODULES**

Chapter 3: THz Generation

Chapter 4: THz Detection

Chapter 5: THz Manipulation

**APPLICATIONS**

Chapter 6: THz Imaging

Chapter 7: THz Communication

Chapter 8: THz Energy Harvesting

### Literature

- Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009


### Prerequisites / notice

Good foundation in electromagnetics & knowledge of microwave or optical communication is helpful.

### 227-0468-00L Analog Signal Processing and Filtering

**Objective**

This lecture provides a wide overview over analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers.

**Abstract**

At the beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during the whole term to analyze circuits and understand how signals propagate through them. The theory and CMOS implementation of active Filters is then discussed in detail using the example of Gm-C filters and active-RC filters. The ideal and nonideal behaviour of opamps, current conveyors, and inductor simulators follows. The link to the practical design of circuits and systems is done with an overview over different quality measures and figures of merit used in scientific literature and datasheets. Finally, an introduction to discrete-time and mixed-domain filters and circuits is given, including sensor read-out amplifiers, correlated double sampling, and chopping, and an introduction to sigma-delta A/D and D/A conversion on a system level.

**Content**

At the beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during the whole term to analyze circuits and understand how signals propagate through them. The theory and CMOS implementation of active Filters is then discussed in detail using the example of Gm-C filters and active-RC filters. The ideal and nonideal behaviour of opamps, current conveyors, and inductor simulators follows. The link to the practical design of circuits and systems is done with an overview over different quality measures and figures of merit used in scientific literature and datasheets. Finally, an introduction to discrete-time and mixed-domain filters and circuits is given, including sensor read-out amplifiers, correlated double sampling, and chopping, and an introduction to sigma-delta A/D and D/A conversion on a system level.

**Lecture notes**

The base for these lectures are lecture notes and two or three published scientific papers. From these papers we will together develop the technical content.

Details: https://people.ee.ethz.ch/~haschmid/asfwiki/

Some material is protected by password; students from ETHZ who are interested can write to haschmid@ethz.ch to ask for the password even if they do not attend the lecture.

**Prerequisites / notice**

Prerequisites: Recommended (but not required): Stochastic models and signal processing, Communication Electronics, Analog Integrated Circuits, Transmission Lines and Filters.

Knowledge of the Laplace transform and z transform and their interpretation (transfer functions, poles and zeros, bode diagrams, stability criteria ...) and of the main properties of linear systems is necessary.

### 227-0617-00L Solar Cells

**Objective**

Introduction to solar radiation, physics, technology, characteristics and applications of photovoltaic solar cells.

**Content**

Solar cell processing, characteristics, and applications of photovoltaic solar cells and systems.

**Lecture notes**

Lecture reprints (in english).

**Prerequisites / notice**

Prerequisites: Basic knowledge of semiconductor properties.

### 227-0618-00L Modeling, Characterization and Reliability of Power Semiconductors

**Objective**

This lecture provides theoretical and experimental knowledge on the techniques for the characterization and numerical modeling of power semiconductors, as well on the related built-in reliability strategies.

**Abstract**

The students shall get acquainted with the most important concepts and techniques for characterization, numerical modeling and built-in reliability of modern power semiconductor devices. This knowledge is intended to provide the future engineer with the theoretical background and tools for the design of dependable power devices and systems.

**Prerequisites / notice**

Some material is protected by password; students from ETHZ who are interested can write to haschmid@ethz.ch to ask for the password even if they do not attend the lecture.

**Lecture notes**

Lecture reprints (in english).

**Prerequisites / notice**

Prerequisites: Basic knowledge of semiconductor properties.
The seminar aims at instructing graduate and PhD students in the basics of presentation techniques, i.e. "how to give a professional talk".

Attendees have the possibility to become acquainted with a current topic by a literature study, and to present the results thereof in a 20 minutes talk in English. The participation at the seminar gives also an overview on current problems in modern nano- and opto-electronics. The seminar topics are simulation of nano-electronic processes and devices, and the optical as well as electronical simulation of optoelectronic devices as lasers, photodiodes, etc.

The students learn how to find the right literature for a certain topic quickly, as well as how to prepare a talk for a scientific conference, i.e. presentation techniques.

Lecture notes
Handouts to the lecture (approx. 200 pp.)

Literature
Schroeder D.K, Semiconductor Material and Device Characterization, Wiley Ed.

3G
4G
Script and exercices sheets.

This lecture consists of a theoretical part (50%) and of laboratory exercises and demonstrations (50%).

The theoretical part covers the basic techniques and procedures for characterization, modeling and built-in reliability of modern power semiconductor devices with special attention to MOS and IGBT. The starting part on technology provides an overview on the main device families and includes a review of the most relevant application-oriented aspects of the device physics, thermal management, and packaging.

The second section deals with the basic experimental characterization of the electronic properties of semiconductors and thin film materials used in microelectronics, with special focus on silicon. The characterization of the electronic properties of semiconductor and related materials is fundamental to manufacture integrated devices, which fulfill the required specifications.

By this lecture, the students shall get acquainted with the main electrical characterization techniques of the electronic properties of semiconductors and thin film materials used in microelectronics, as well as with their physical principles. This knowledge is intended to provide the future engineer with the theoretical background and experimental tools for process control in semiconductor manufacturing, parameter extraction in device simulation, and of dependable devices.

This lecture consists of a theoretical part (80%) and of laboratory exercises and demonstrations (20%). In the first section of the lecture, methods and procedures are presented for the experimental characterization of relevant electronic parameters in the bare semiconductor (mainly silicon), like resistivity, carrier and doping density, contact resistance, and Schottky barriers, defect density, carrier lifetime, mobility.

The second section deals with techniques involving basic structures and devices (contact chains, MIS capacitors, diodes, gated diodes, BJT, MOSFET) for the characterization of atomic transport, mechanical stress, dielectric thickness, impact ionization, channel mobility, instabilities, defect formation at interfaces and in thin film dielectrics, carrier transport and trapping in thin film dielectrics, quasi-static and dynamic device characteristics. The list of the covered methods includes among others probing, Kelvin measurements, VanderPauw technique, Hall spectroscopy, SIMS, Raman spectroscopy, spreading resistance, scanning probe techniques, static/high-speed I-V, static/high-frequency C-V, open circuit voltage decay, carrier recombination techniques, Zerbst techniques, deep level transient spectroscopy, split C-V, charge pumping, and inverse modeling techniques using TCAD. All methods are presented in conjunction with the proper test structures.

During the laboratory activities, a selection of the experimental techniques discussed in the lecture are demonstrated on the base of realistic examples.

This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

Can the weather forecast also be processed with GPUs?

How can data streams of about 30 TB/s, produced by a protone accelerator, be processed in real time?

Which computer architecture is hidden behind a professional digital audio mixing desk?

Which computer architectures are applied for driver assistance systems?

Which architecture is behind the alarm center of the Swiss Railway (SBB)?

Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)?
The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, line equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetic-thermal analysis of MEMS.

In the second part of the course the students will work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.

### 151-0601-00L Theory of Robotics and Mechatronics

**W 4 credits 3G P. Korba, S. Stoeter, B. Nelson**

**Abstract**

This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Its a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

**Objective**

Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

**Content**

An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. The course will be taught in English.

**Prerequisites / notice**

The course will be taught in English.

### 151-0605-00L Nanosystems

**W 4 credits 4G A. Stemmer, J.N. Tisserant**

**Abstract**

From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures. Special emphasis on the emerging field of molecular electronic devices.

**Objective**

Familiarize students with basic science and engineering principles governing the nano domain.

**Content**

The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately. Special emphasis is placed on the emerging field of molecular electronic devices, their working principles, applications, and how they may be assembled.

**Prerequisites / notice**

The course will be taught in English.

**Course format:**

Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

**Homework:** Mini-Reviews

Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

### 151-0620-00L Embedded MEMS Lab

**W 5 credits 3P C. Hierold, S. Blunier, M. Haluska**

**Abstract**

Practical course: Students are introduced to the process steps required for the fabrication of MEMS (Micro Electro Mechanical System) and carry out the fabrication and testing steps in the clean rooms by themselves. Additionally, they learn the requirements for working in clean rooms. Processing and characterization will be documented and analyzed in a final report. Limited access

**Objective**

Students learn the individual process steps that are required to make a MEMS (Micro Electro Mechanical System). Students carry out the process steps themselves in laboratories and clean rooms. Furthermore, participants become familiar with the special requirements (cleanliness, safety, operation of equipment and handling hazardous chemicals) of working in the clean rooms and laboratories. The entire production, processing, and characterization of the MEMS is documented and evaluated in a final report.

**Content**

With guidance from a tutor, the individual silicon microsystem process steps that are required for the fabrication of an accelerometer are carried out:

- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Packaging and electrical connection of a MEMS device
- Testing and characterization of the MEMS device
- Written documentation and evaluation of the entire production, processing and characterization

**Lecture notes**

A document containing theory, background and practical course content is distributed at the first meeting of the course.

**Content**

The document provides sufficient information for the participants to successfully participate in the course.
This master's level course is limited to 15 students per semester for safety and efficiency reasons. If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

Priority 1: master students of the master's program in "Micro and Nanosystems"

Priority 2: master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering (MNAV-tutors Profs Daraio, Dual, Hierold, Koumoutsakos, Nelson, Norris, Park, Poulikakos, Pratsinis, Stemmer), who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

Priority 3: master students, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

Priority 4: all other students (PhD, bachelor, master) with a background in silicon or microsystems process technology.

If there are more students in one of these priority groups than places available, we will decide by drawing lots.

Students will be notified at the first lecture of the course (introductory lecture) as to whether they are able to participate.

The course is offered in autumn and spring semester.

<table>
<thead>
<tr>
<th>151-0911-00L</th>
<th>Introduction to Plasmonics</th>
<th>W</th>
<th>4 credits</th>
<th>2V+1U</th>
<th>D. J. Norris</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics. Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.</td>
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<tr>
<td>Content</td>
<td>Class notes and handouts</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Physics I, Physics II</td>
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<thead>
<tr>
<th>363-0389-00L</th>
<th>Technology and Innovation Management</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>S. Brusoni</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course focuses on the analysis of innovation as a pervasive process that cut across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.</td>
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<tr>
<td>Objective</td>
<td>This course intends to enable all students to: - understand the core concepts necessary to analyze how innovation happens - master the most common methods and tools organizations deploy to innovate - develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation</td>
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<tr>
<td>Content</td>
<td>This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success are small. How do firms организize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.</td>
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<tr>
<td>Lecture notes</td>
<td>Slides will be available on the TIMGROUP website.</td>
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<tr>
<td>Literature</td>
<td>Readings will be available on the TIMGROUP website.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>No specific background in economics or management is required.</td>
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### Energy and Power Electronics

#### Core Subjects

These core subjects are particularly recommended for the field of "Energy and Power Electronics".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0247-00L</td>
<td>Power Electronic Systems I</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>J. W. Kolar</td>
</tr>
</tbody>
</table>

Basics of the switching behavior, gate drive and snubber circuits of power semiconductors are discussed. Soft-switching and resonant DC/DC converters are analyzed in detail and high frequency loss mechanisms of magnetic components are explained. Space vector modulation of three-phase inverters is introduced and the main power components are designed for typical industry applications.
Objective
Detailed understanding of the principle of operation and modulation of advanced power electronics converter systems, especially of zero
voltage switching and zero current switching non-isolated and isolated DC/DC converter systems and three-phase voltage DC link inverter
systems. Furthermore, the course should convey knowledge on the switching frequency related losses of power semiconductors and
inductive power components and introduce the concept of space vector calculus which provides a basis for the comprehensive discussion
of three-phase PWM converters systems in the lecture Power Electronic Systems II.

Content
Basics of the switching behavior and gate drive circuits of power semiconductor devices and auxiliary circuits for minimizing the switching
losses are explained. Furthermore, zero voltage switching, zero current switching, and resonant DC/DC converters are discussed in detail;
the operating behavior of isolated full-bridge DC/DC converters is detailed for different secondary side rectifier topologies; high frequency
loss mechanisms of magnetic components of converter circuits are explained and approximate calculation methods are presented; the
concept of space vector calculus for analyzing three-phase systems is introduced; finally, phase-oriented and space vector modulation of
three-phase inverter systems are discussed related to voltage DC link inverter systems and the design of the main power components
based on analytical calculations is explained.

Lecture notes
Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including
visualization/animation features.

Prerequisites / notice
Prerequisites: Introductory course on power electronics.

227-0517-00L Electrical Drive Systems II W 6 credits 4G P. Steimer, G. Scheuer, C. A. Stulz

Abstract
In the course "Drive System II" the power semiconductors are repeated. The creation of converters based on the combination of
switches/cells and based topologies is explained. Another main focus is on the 3-level inverter with its switching and transfer functions.
Further topics are the control of the synchronous machine, of line-side converters and issues with converter-fed machines

Objective
The students establish a deeper understanding in regards of the design of the main components of an electrical drive system. They
establish knowledge on the most important interaction with the grid and the machine and their related high dynamic control

Content
Converter topologies (switch or cell based), multi-pulse diode rectifiers, system aspects of transformer and electrical machines, 3-level
inverter with its switching and transfer functions, grid side harmonics, modeling and control of synchronous machines (including permanent
magnet machines), control of line-side converters, reflection effects with power cables, winding isolation and bearing stress. Field trip to
ABB Semiconductors.

Lecture notes
Lecture notes are sold at the beginning of the lectures or can be downloaded from Ilias

Literature
Skript is sold at the beginning of the lectures or can be downloaded from Ilias

Prerequisites / notice
Prerequisites: Electrical Drive Systems I (recommended), Basics in electrical engineering, power electronics, automation and mechatronics

227-0526-00L Power System Analysis W 6 credits 4G G. Hug

Abstract
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the
development of stationary models of the electrical network, their mathematical representation and special characteristics and solution
methods of large linear and non-linear systems of equations related to electrical power networks.

Objective
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the
development of stationary models of the electrical network, their mathematical representation and special characteristics and solution
methods of large linear and non-linear systems of equations related to electrical power networks.

Content
The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand
oriented, operationally, economically), network planning and network operation, models of N-port network components (line, cables,
shunts, transformers), the p.u. computation, computer oriented network models, linear networks (solution methods - direct, iterative),

Lecture notes
Lecture notes. Course is supported by WWW-teaching system.

227-0567-00L Design of Power Electronic Systems W 6 credits 4G F. Krismer

Abstract
Complete design process: from given specifications to a complete power electronic system; selection / design of suitable passive power
components; static and dynamic properties of power semiconductors; optimized EMI filter design; heat sink optimization; additional
circuitry, e.g. gate driver; system optimization.

Objective
Basic knowledge of design and optimization of a power electronic system; furthermore, lecture and exercises thoroughly discuss key
subjects of power electronics that are important with respect to a practical realization, e.g. how to select suitable power components, how
to determine switching losses, calculation of high frequency losses, EMI filter design and realization, thermal considerations.

Content
Complete design process: from given specifications to a complete power electronic system.
Selection and / or design of suitable passive power components: specific properties, parasitic components, tolerances.
Thermal characterization of the converter, optimized heat sink design.
Additional circuitry: gate driver, measurement, control.
Converter start up: typical sequence of events, circuitry required.
Overall system optimization: identifying couplings between different components of the considered power electronic system, optimization
targets and issues.

Lecture notes
Lecture notes and complementary exercises including correct answers.

Prerequisites / notice
Prerequisites: Introductory course on power electronics.

227-0731-00L Power Market I - Portfolio and Risk Management W 6 credits 4G D. Reichelt, G. A. Koeppe

Abstract
Portfolio and risk management in the electrical power business, Pan-European power market and trading, futures and forward contracts,
hedging, options and derivatives, performance indicators for the risk management, modelling of physical assets, cross-border trading,

Objective
Knowledge on the worldwide liberalisation of electricity markets, pan-European power trading and the role of power exchanges. Understand
financial products (derivatives) based on power. Management of a portfolio containing physical production, contracts and derivatives.
Evaluate trading and hedging strategies. Apply methods and tools of risk management.
Content

1. Pan-European power market and trading
   1.1. Power trading
   1.2. Development of the European power markets
   1.3. Energy economics
   1.4. Spot and OTC trading
   1.5. European energy exchange EEX

2. Market model
   2.1. Market place and organisation
   2.2. Balance groups / balancing energy
   2.3. Ancillary services
   2.4. Market for ancillary services
   2.5. Cross-border trading
   2.6. Capacity auctions

3. Portfolio and Risk management
   3.1. Portfolio management 1 (introduction)
   3.2. Forward and futures contracts
   3.3. Risk management 1 (m2m, VaR, hpfc, volatility, cVaR)
   3.4. Risk management 2 (PaR)
   3.5. Contract valuation (HPFC)
   3.6. Portfolio management 2
   2.8. Risk Management 3 (enterprise wide)

4. Energy & Finance I
   4.1. Options 1 basics
   4.2. Options 2 hedging with options
   4.3. Introduction to derivatives (swaps, cap, floor, collar)
   4.4. Financial modelling of physical assets
   4.5. Trading and hydro power
   4.6. Incentive regulation

Lecture notes
Handouts of the lecture
Prerequisites / notice
1 excursion per semester, 2 case studies, guest speakers for specific topics.
Course Moodle: https://moodle-app2.let.ethz.ch/course/view.php?id=2196

Recommended Subjects
These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0101-00L</td>
<td>Discrete-Time and Statistical Signal Processing</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>H.A. Loeliger</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.</td>
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<tr>
<td>Objective</td>
<td>The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are linearity and probability. In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm. A recurrent theme throughout the course is the stable and robust &quot;inversion&quot; of a linear filter.</td>
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<tr>
<td>Content</td>
<td>1. Discrete-time linear systems and filters: state-space realizations, z-transform and spectrum, decimation and interpolation, digital filter design, stable realizations and robust inversion.</td>
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<td>2. The discrete Fourier transform and its use for digital filtering.</td>
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<td>3. The statistical perspective; probability, random variables, discrete-time stochastic processes; detection and estimation: MAP, ML, Bayesian MMSE, LMMSE; Wiener filter, LMS adaptive filter, Viterbi algorithm.</td>
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<td>Lecture notes</td>
<td>Lecture Notes.</td>
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<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0121-00L</td>
<td>Communication Systems</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>A. Wittneben</td>
</tr>
<tr>
<td>Abstract</td>
<td>Information Theory, Signal Space Analysis, Baseband Transmission, Passband Transmission, Example und Channel, Data Link Layer, MAC, Example Layer 2, Layer 3, Internet</td>
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<tr>
<td>Objective</td>
<td>Introduction into the fundamentals of digital communication systems. Selected examples on the application of the fundamental principles in existing and upcoming communication systems</td>
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<tr>
<td>Content</td>
<td>Covered are the lower three layer of the OSI reference model: the physical, the data link, and the network layer. The basic terms of information theory are introduced. After this, we focus on the methods for the point to point communication, which may be addressed elegantly and coherently in the signal space. Methods for error detection and correction as well as protocols for the retransmission of perturbed data will be covered. Also the medium access for systems with shared medium will be discussed. Finally, algorithms for routing and flow control will be treated.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture Slides.</td>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0225-00L</td>
<td>Linear System Theory</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>M. Kamarpour</td>
</tr>
<tr>
<td>Abstract</td>
<td>The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.</td>
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<tr>
<td>Objective</td>
<td>By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.</td>
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</tbody>
</table>
This lecture consists of a theoretical part (50%) and of laboratory exercises and demonstrations (50%).

Modeling, Characterization and Reliability of Power
Overview of the technical characteristics of railway systems

The students shall get acquainted with the most important concepts and techniques for characterization, numerical modeling and built-in reliability of modern power semiconductor devices. This knowledge is intended to provide the future engineer with the theoretical background and tools for the design of dependable power devices and systems.

Objective

Content

227-0523-00L Railway Systems I W 6 credits 4G M. Meyer

Abstract

Basic characteristics of railway vehicles and their interfaces with the railway infrastructure:
- Transportation tasks and vehicle types
- Running dynamics
- Mechanical part of rail vehicles
- Brakes
- Traction chain and auxiliary supply
- Railway power supply
- Signalling systems
- Traffic control and maintenance

Content

1 Einführung:
1.1 Geschichte und Struktur des Bahnsystems
1.2 Fahrdynamik

2 Vollbahnfahrzeuge:
2.1 Mechanik: Kasten, Drehgestelle, Lauftechnik, Adhäsion
2.2 Bremsen
2.3 Traktionsantriebssysteme
2.4 Hilfsbetriebe und Komfortanlagen
2.5 Steuerung und Regelung

3 Infrastruktur:
3.1 Fahrweg
3.2 Bahnstromversorgung
3.3 Sicherungsanlagen

4 Betrieb:
4.1 Interoperabilität, Normen und Zulassung
4.2 RAMS, LCC
4.3 Anwendungsbeispiele

Voraussichtlich ein oder zwei Gastvorträge

Lecture notes

Geplante Exkursionen:
- Betriebszentrale SBB, Zürich Flughafen
- Reparatur und Unterhalt, SBB Zürich Altstetten
- Fahrzeugfertigung, Stadler Bussnang

Prerequisites / notice

Prerequisites: Control Systems I (227-0103-00) or equivalent and sufficient mathematical maturity.

4.3 Anwendungsbeispiele

4.2 RAMS, LCC

4.1 Interoperabilität, Normen und Zulassung

227-0618-00L Modeling, Characterization and Reliability of Power W 6 credits 4G M. P. M. Ciappa

Abstract

This lecture provides theoretical and experimental knowledge on the techniques for the characterization and numerical modeling of power semiconductors, as well as on the related built-in reliability strategies.

Objective

The students shall get acquainted with the most important concepts and techniques for characterization, numerical modeling and built-in reliability of modern power semiconductor devices. This knowledge is intended to provide the future engineer with the theoretical background and tools for the design of dependable power devices and systems.

Content

This lecture consists of a theoretical part (50%) and of laboratory exercises and demonstrations (50%). The theoretical part covers the basic techniques and procedures for characterization, modeling and built-in reliability of modern power semiconductor devices with special attention to MOS and IGBT. The starting part on technology provides an overview on the main device families and includes a review of the most relevant application-oriented aspects of the device physics, thermal management, and packaging. The second section deals with the basic experimental characterization techniques for the definition of the semiconductor material properties, electrical characteristics, safe operating area, and junction temperature of the devices. The following section introduces the basic principles for electrical, thermal, and electro-thermal simulation of power semiconductors by Technology Computed Aided Design (TCAD) and compact modeling. Finally, procedures are methods are presented to implement efficient built-in reliability programs targeted on power semiconductors. They include failure physics, dedicated failure analysis techniques, accelerated testing, defect screening, and lifetime modeling.

During the laboratory activities, selections of the experimental techniques presented in the lecture are demonstrated on the base of realistic examples. Furthermore, schematic power devices will be simulated by the students with advanced TCAD tools and circuit simulators.

227-0523-00L Railway Systems I

227-0618-00L Modeling, Characterization and Reliability of Power

Semiconductors

Lecture notes

Handouts to the lecture (approx. 250 pp.)
Introduction to process automation: system architecture, data handling, communication (fieldbusses), process visualization, engineering, etc.

Analysis and design of open loop control problems: discrete automata, decision tables, petri-nets, drive control and object oriented function group automation philosophy, RT-UML.

Engineering: Application programming in IEC61131-3 (function blocks, sequence control, structured text); process visualization and operation; engineering integration from sensor, cabling, topology design, function, visualization, diagnosis, to documentation; Industry standards (e.g. OPC, Profibus); Ergonomic design, safety (IEC61508) and availability, supervision and diagnosis.

Practical examples from process industry, power generation and newspaper production.

Slides will be available as .PDF documents, see "Learning materials" (for registered students only)

Lecturers: G. Maier, A. Horch

Prerequisites / notice: Practical exercises will illustrate some topics, e.g. some control software coding using industry standard programming tools based on IEC61131-3.

International Business Management for Engineers

Globalization of markets increases global competition and requires enterprises to continuously improve their performance to sustainably survive. Engineers substantially contribute to the success of an enterprise provided they understand and follow fundamental international market forces, economic basics and operational business management.

The goal of the lecture is to get a basic understanding of international market mechanisms and their consequences for a successful enterprise. Students will learn by practical examples how to analyze international markets, competition as well as customer needs and how they convert into a successful portfolio an enterprise offers to the global market. They will understand the basics of international business management, why efficient organizations and effective business processes are crucial for the successful survival of an enterprise and how all this can be implemented.

The first part of the course provides an overview about the development of international markets, the expected challenges and the players in the market. The second part is focusing on the economic aspects of an enterprise, their importance for the long term success and how to effectively manage an international business. Based on these fundamentals the third part of the course explains how an innovative product portfolio of a company can be derived from considering the most important external factors and which consequences in respect of product innovation, competitive product pricing, organization and business processes emerge. Each part of the course includes practical examples to demonstrate the procedure.

A script is provided for this lecture.

The lecture will be held in three blocks each of them on a Saturday. Each block will focus on one of the three main topics of the course. Between the blocks the students will work on specific case studies to deepen the subject matter. About two weeks after the third block a written examination will be conducted.

Dynamic Programming and Optimal Control

Introduction to Dynamic Programming and Optimal Control.

Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

Numerical methods used to derive them.

Estimation and their applications to areas ranging from avionics to systems biology.

Number of credits: 4

Type of credit: ECTS

Hours: 5G

Lecturers: R. D’Andrea

Core Subjects

These core subjects are particularly recommended for the field of “Systems and Control”.

Linear System Theory

The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.

By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.

- Rings, fields and linear spaces, normed linear spaces and inner product spaces.
- Ordinary differential equations, existence and uniqueness of solutions.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Stability and stabilization, observers, state and output feedback, separation principle.
- Realization theory.


Prerequisites / notice: Prerequisites: Control Systems I (227-0103-00) or equivalent and sufficient mathematical maturity.

Industrial Process Control

Introduction to process automation and its application in process industry and power generation

Knowledge of process automation and its application in industry and power generation

Introduction to process automation: system architecture, data handling, communication (fieldbusses), process visualization, engineering, etc.

Analysis and design of open loop control problems: discrete automata, decision tables, petri-nets, drive control and object oriented function group automation philosophy, RT-UML.

Engineering: Application programming in IEC61131-3 (function blocks, sequence control, structured text); process visualization and operation; engineering integration from sensor, cabling, topology design, function, visualization, diagnosis, to documentation; Industry standards (e.g. OPC, Profibus); Ergonomic design, safety (IEC61508) and availability, supervision and diagnosis.

Practical examples from process industry, power generation and newspaper production.

Slides will be available as .PDF documents, see "Learning materials" (for registered students only)
Prerequisites / notice
Exercises: Tuesday 15-16
Practical exercises will illustrate some topics, e.g., some control software coding using industry standard programming tools based on IEC61131-3.

151-0563-01L Dynamic Programming and Optimal Control W 4 credits 2V+1U R. D’Andrea
Abstract
Introduction to Dynamic Programming and Optimal Control.
Objective
Covers the fundamental concepts of Dynamic Programming & Optimal Control.
Content
Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.
Literature
Prerequisites / notice
Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

Recommended Subjects
These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0102-00L</td>
<td>Discrete Event Systems</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>L. Thiele, L. Vanbever, R. Wattenhofer</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus. Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g., hitting a keyboard key, sending a message), some not (e.g., spontaneous failure, packet loss). The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems. In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.</td>
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<tr>
<td></td>
<td>Objective</td>
<td></td>
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<td></td>
<td>Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g., hitting a keyboard key, sending a message), some not (e.g., spontaneous failure, packet loss). The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems. In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.</td>
</tr>
</tbody>
</table>
|          | Content                         |      |      |       | 1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus |
|          | Lecture notes                   |      |      |       | Available |
|          | Literature                      |      |      |       | [bertsekas] Data Networks
Dimitri Bertsekas, Robert Gallager
|          |                                 |      |      |       | [borodin] Online Computation and Competitive Analysis
Allan Borodin, Ran El-Yaniv
Cambridge University Press, 1998 |
|          |                                 |      |      |       | [boudec] Network Calculus
J.-Y. Le Boudec, P. Thiran
Springer, 2001 |
|          |                                 |      |      |       | [cassandras] Introduction to Discrete Event Systems
Christos Cassandras, Stéphane Lafortune
|          |                                 |      |      |       | [fafi] Online Algorithms: The State of the Art
A. Fiat and G. Woeginger |
D. Hochbaum |
|          |                                 |      |      |       | [schi] Diskrete Strukturen (Band 2: Wahrscheinlichkeitsrechnung und Statistik)
T. Schickinger, A. Steger
Springer, Berlin, 2001 |
|          |                                 |      |      |       | [sipser] Introduction to the Theory of Computation
Michael Sipser.

227-0447-00L Image Analysis and Computer Vision W 6 credits 3V+1U L. Van Gool, O. Gökşel, E. Konukoglu
Abstract
Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.
Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Prequisites / notice
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.
The course language is English.

227-0526-00L Power System Analysis
W 6 credits 4G G. Hug
Abstract
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large and non-linear systems of equations related to electrical power networks.
Objective
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large and non-linear systems of equations related to electrical power networks.
Content
The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand oriented, operationally, economically), network planning and network operation, models of network components (line, cables, transformers), the p.u. computation, computer oriented network models, linear networks (solution methods - direct, iterative), algorithms for the solution of non-linear sets of equations, derived from the electrical power system (Newton-Raphson), power flow computation (problem definition, solution methods), three phase short-circuit computation, application of power flow algorithms. Introduction to power system stability.

Lecture notes
Course notes. Course is supported by WWW-teaching system.

227-0689-00L System Identification
W 4 credits 2V+1U R. Smith
Abstract
To provide a series of practical techniques for the development of dynamical models from experimental data, with the emphasis being on the development of models suitable for feedback control design purposes. To provide sufficient theory to enable the practitioner to understand the trade-offs between model accuracy, data quality and data quantity. An introduction to modeling: Black-box and grey-box models; Parametric and non-parametric models; ARX, ARMAX (etc.) models.
Objective
Predictive, open-loop, black-box identification methods. Time and frequency domain methods. Subspace identification methods.
Content

Literature

Prerequisites / notice
Control systems (227-0216-00L) or equivalent.

227-0945-00L Cell and Molecular Biology for Engineers I
W 3 credits 3G C. Frei
This course is part I of a two-semester course.
Abstract
The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.
Objective
After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested. Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.

Lecture notes
Scripts of all lectures will be available.

Literature

151-0104-00L Uncertainty Quantification for Engineering & Life Sciences
W 4 credits 3G P. Koumoutsakos
Number of participants limited to 60.
Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.
Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.
Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes
This course is intended for Masters and Ph.D. students in engineering sciences, physics and applied mathematics who are interested in the behavior of nonlinear dynamical systems. It offers an introduction to the qualitative study of nonlinear physical phenomena modeled by differential equations or discrete maps. We discuss applications in classical mechanics, electrical engineering, fluid mechanics, and biology. A more advanced Part II of this class is offered every other year.

### Content

1. Basic facts about nonlinear systems: Existence, uniqueness, and dependence on initial data.
2. Near equilibrium dynamics: Linear and Lyapunov stability
3. Bifurcations of equilibria: Center manifolds, normal forms, and elementary bifurcations
4. Nonlinear dynamical systems on the plane: Phase plane techniques, limit sets, and limit cycles.
5. Time-dependent dynamical systems: Floquet theory, Poincare maps, averaging methods, resonance

### Prerequisites / notice

- Prerequisites: Analysis, linear algebra and a basic course in differential equations.
- Exam: two-hour written exam in English.
- Homework: A homework assignment will be due roughly every other week. Hints to solutions will be posted after the homework due dates.

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**Nonlinear Dynamics and Chaos I**

<table>
<thead>
<tr>
<th>Subject</th>
<th>ECTS</th>
<th>Credits</th>
<th>Sem.</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Modeling</td>
<td>151-0573-00L</td>
<td>4 credits</td>
<td>W</td>
<td>English</td>
</tr>
<tr>
<td>Theory of Robotics and Mechatronics</td>
<td>151-0601-00L</td>
<td>4 credits</td>
<td>W</td>
<td>English</td>
</tr>
<tr>
<td>Dynamic Programming and Optimal Control</td>
<td>151-0563-01L</td>
<td>4 credits</td>
<td>W</td>
<td>English</td>
</tr>
<tr>
<td>Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions</td>
<td>376-1219-00L</td>
<td>3 credits</td>
<td>W</td>
<td>English</td>
</tr>
</tbody>
</table>

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**Prerequisites**

- Fundamentals of Probability, Fundamentals of Computational Modeling

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**Objective**

- The course will be taught in English.
- The course is available.
- The course will be taught in English.

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**Abstract**

- Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. It's a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.
- Introduction to Dynamic Programming and Optimal Control.
- Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.
- Rehabilitation Engineering II is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

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**Content**

- Introduction to Dynamic Programming and Optimal Control.
- Covers the fundamental concepts of Dynamic Programming & Optimal Control.
- Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.
- Rehabilitation engineering can provide sensory restoration and substitution.

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**Prerequisites / notice**

- Fundamentals of Probability, Fundamentals of Computational Modeling
- Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

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**Literature**

- A list of references is included in the handouts.
- The handsouts in English will be sold in the first lecture.
- The course will be taught in English.

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**Lecture notes**

- The lecture notes will be posted electronically after each lecture. Students should not rely on these but prepare their own notes during the lecture.
- The class lecture notes will be posted electronically after each lecture. Students should not rely on these but prepare their own notes during the lecture.
- The exercises address practical examples. One larger case study is to be solved.

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**Objective**

- Introduction to Dynamic Programming and Optimal Control.
- Covers the fundamentals of Dynamic Programming & Optimal Control.
- Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.
- Rehabilitation Engineering II is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

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**Abstract**

- The course will be taught in English.
- The course will be taught in English.
- The course will be taught in English.
- The course will be taught in English.
Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces

Literature

Introductory Books:


Selected Journal Articles and Web Links:

Prerequisites / notice

Prerequisites:
- Students of higher semesters and PhD students of
  - D-MAVT, D-ITET, D-INFK, D-HEST
  - Biomedical Engineering, Robotics, Systems and Control
  - Medical Faculty, University of Zurich
  - Students of other departments, faculties, courses are also welcome

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

401-0647-00L Introduction to Mathematical Optimization W 5 credits 2V+1U D. Adjiashvili
Lecture notes for the course "Visualization, Simulation and Interaction - Virtual Reality" by A. Kunz and R. Weismantel.

**Abstract**

Introduction to basic techniques and problems in mathematical optimization, and their applications to problems in engineering.

**Objective**

The goal of the course is to obtain a good understanding of some of the most fundamental mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems. The students will also practice applying the learned models to problems in engineering.

**Content**

Topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...)
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...). Modelling with mathematical optimization: applications of mathematical programming in engineering.

**Literature**

Information about relevant literature will be given in the lecture.

**Prerequisites / Notice**

This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

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**Course Codes and Information**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3901-00L</td>
<td>Mathematical Optimization</td>
<td>W</td>
<td>11</td>
<td>4V+2U</td>
<td>R. Weismantel</td>
</tr>
<tr>
<td>Abstract</td>
<td>Mathematical treatment of diverse optimization techniques.</td>
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<tr>
<td>Objective</td>
<td>Advanced optimization theory and algorithms.</td>
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</tr>
<tr>
<td>Content</td>
<td>1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems. Farkas’ Lemma and infeasibility certificates, duality theory of linear programming.</td>
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<td>3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.</td>
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<td>4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.</td>
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<tr>
<td>636-0007-00L</td>
<td>Computational Systems Biology</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>J. Stelling</td>
</tr>
<tr>
<td>Abstract</td>
<td>Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).</td>
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<tr>
<td>Objective</td>
<td>The aim of the course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.</td>
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<tr>
<td>Content</td>
<td>Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label &quot;Systems Biology&quot;, focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.</td>
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<td></td>
<td>We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.</td>
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**Subjects of General Interest**

- **Physics of Failure and Failure Analysis of Electronic Devices and Equipment**
  - **Abstract**
    - Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.
  - **Objective**
    - Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.
  - **Content**
    - Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis.
  - **Lecture notes**
    - Comprehensive copy of transparencies

- **Technology Entrepreneurship**
  - **Abstract**
    - Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding.
  - **Objective**
    - Introduction to the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.
  - **Content**
    - Case studies and a critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.
  - **Lecture notes**
    - Comprehensive copy of transparencies

- **Visualization, Simulation and Interaction - Virtual Reality II**
  - **Abstract**
    - This course provides deeper knowledge on the possible applications of virtual reality, its basic technology, and future research fields. The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes.
  - **Objective**
    - Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems. The goal of the lecture is to provide a deeper knowledge of today's VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.
Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of simulation; compression procedures of image-, audio-, and video signals; new materials for force feedback devices; introduction into data security; cryptography; definition of free-form surfaces; digital factory; new research fields of virtual reality.

Lecture notes

The handout is available in German and English.

Prerequisites / notice

Prerequisites:

"Visualization, Simulation and Interaction - Virtual Reality I" is recommended.

Didactical concept:

The course consists of lectures and exercises.

### Semester Projects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly recommended prerequisite for Semester Projects and Master Theses at D-ITET (MSc BME, MSc EEIT, MSc EST).</td>
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<tr>
<td></td>
<td>E-</td>
<td>0</td>
<td>credits</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>J. Leuthold</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Abstract**

The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

**Objective**

Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

**Content**

* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the-Art, the “in this paper” paragraph, the scientific part, the summary, Equations, Figures).

* Topic 2: Power Point Presentations.

* Topic 3: Citation Rules and Citation Software.

* Topic 4: Guidelines for Research Integrity.

**Literature**

ETH "Citation Etiquette", see www.plagiate.ethz.ch.


**Prerequisites / notice**

Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1572-01L</td>
<td>Semester Project (Nr 1) ■ Registration in mystudies required!</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Supervisor must be a professor at D-ITET or associated, see <a href="https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html">https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html</a></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>W</td>
<td>8</td>
<td>credits</td>
<td>20A</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

**Abstract**

Semester projects are designed to train the students for independent scientific work. A project uses the student's technical and social skills acquired during the master's program. The semester project comprises 280 hours of work and is supervised by a professor.

**Objective**

see above

**Prerequisites / notice**

Supervisor must be a professor at D-ITET or associated, see https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1572-02L</td>
<td>Semester Project (Nr 2) ■ Registration in mystudies required!</td>
<td></td>
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<tr>
<td></td>
<td>Supervisor must be a professor at D-ITET or associated, see <a href="https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html">https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html</a></td>
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<tr>
<td></td>
<td>W</td>
<td>8</td>
<td>credits</td>
<td>20A</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

**Abstract**

Semester projects are designed to train the students for independent scientific work. A project uses the student's technical and social skills acquired during the master's program. The semester project comprises 280 hours of work and is supervised by a professor.

**Objective**

see above

**GESS Science in Perspective**

Recommended Science in Perspective (Type B) for D-ITET

see Science in Perspective: Type A: Enhancement of Reflection Capability

see Science in Perspective: Language Courses ETH/UZH

**Industrial Internship**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1550-00L</td>
<td>Internship in Industry Only for Electrical Engineering and Information Technology MSc.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Z</td>
<td>0</td>
<td>credits</td>
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</tr>
</tbody>
</table>

**Abstract**

The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

**Objective**

see above

**Master's Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly recommended prerequisite for Semester Projects and Master Theses at D-ITET (MSc BME, MSc EEIT, MSc EST).</td>
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<td>E-</td>
<td>0</td>
<td>credits</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>J. Leuthold</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Abstract
The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

Objective
Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

Content
* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the Art, the "in this paper" paragraph, the scientific part, the summary, Equations, Figures).

* Topic 2: Power Point Presentations.

* Topic 3: Citation Rules and Citation Software.

* Topic 4: Guidelines for Research Integrity.

Literature
ETH "Citation Etiquette", see www plagiate.ethz.ch.


Prerequisites / notice
Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-1501-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>68D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

Admission only if ALL of the following apply:

a) bachelor program successfully completed;
b) acquired (if applicable) all credits from additional requirements for admission to master program;
c) successfully completed both semester projects.

Note: the conditions above are not applicable to incoming exchange students.

Registration in mystudies required!
Supervisor must be a professor at D-ITET or associated, see https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html.

Abstract
The Master Program finishes with a 6-months Master Thesis which is directed by a Professor of the Department or a Professor of another Department who is associated with the D-ITET. Students gain the ability to conduct independent scientific research on a specific research problem.

Objective
see above

Prerequisites / notice
Supervisor must be a professor at D-ITET or associated, see https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html

Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0919-00L</td>
<td>Knowledge-Based Image Interpretation</td>
<td>Z</td>
<td>0 credits</td>
<td>2S</td>
<td>L. Van Gool</td>
</tr>
</tbody>
</table>

With the lecture series on special topics of Knowledge based image interpretation we sporadically offer special talks.

To become acquainted with selected, recent results in image analysis and interpretation.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0920-00L</td>
<td>Seminar in Systems and Control</td>
<td>Z</td>
<td>0 credits</td>
<td>1S</td>
<td>F. Dörfler, R. D'Andrea, J. Lygeros, R. Smith</td>
</tr>
</tbody>
</table>

Current topics in Systems and Control presented mostly by external speakers from academia and industry.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0955-00L</td>
<td>Seminar in Electromagnetics, Photonics and Terahertz</td>
<td>Z</td>
<td>3 credits</td>
<td>2K</td>
<td>J. Leuthold</td>
</tr>
</tbody>
</table>

Selected topics of the current research activities at the IEF and closely related institutions are discussed. Have an overview on the research activities of the IEF institute.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0950-00L</td>
<td>Acoustics</td>
<td>Z</td>
<td>0 credits</td>
<td>0.5K</td>
<td>K. Heutschi</td>
</tr>
</tbody>
</table>

Current topics in Acoustics presented mostly by external speakers from academia and industry

see above

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0970-00L</td>
<td>Research Topics in Biomedical Engineering</td>
<td>Z</td>
<td>0 credits</td>
<td>2K</td>
<td>M. Rudin, S. Kozerke, K. P. Prüssmann, M. Stamppanoni, K. E. Stephan, J. Vörös</td>
</tr>
</tbody>
</table>

Current topics in Biomedical Engineering presented by speakers from academia and industry.

Getting insight into actual areas and problems of Biomedical Engineering an Health Care.

see above

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0980-00L</td>
<td>Seminar on Biomedical Magnetic Resonance</td>
<td>Z</td>
<td>0 credits</td>
<td>2K</td>
<td>K. P. Prüssmann, S. Kozerke, M. Rudin</td>
</tr>
</tbody>
</table>

Actual developments and problems of magnetic resonance imaging (MRI)

Getting insight to advanced topics in Magnetic Resonance Imaging

Course Units for Additional Admission Requirements
The courses below are only available for MSc students with additional requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0101-AAL</td>
<td>Discrete-Time and Statistical Signal Processing</td>
<td>E</td>
<td>6 credits</td>
<td>8R</td>
<td>H.A. Loeliger</td>
</tr>
</tbody>
</table>

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.

The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are linearity and probability. In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm. A recurrent theme throughout the course is the stable and robust "inversion" of a linear filter.

1. Discrete-time linear systems and filters:
   - state-space realizations, z-transform and spectrum,
   - decimation and interpolation, digital filter design,
   - stable realizations and robust inversion.

2. The discrete Fourier transform and its use for digital filtering.

3. The statistical perspective:
   - probability, random variables, discrete-time stochastic processes;
   - detection and estimation: MAP, ML, Bayesian MMSE, LMMSE;
   - Wiener filter, LMS adaptive filter, Viterbi algorithm.

Lecture notes

<table>
<thead>
<tr>
<th>Course</th>
<th>Control Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>227-0103-AAL</td>
</tr>
<tr>
<td>Title</td>
<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
</tr>
<tr>
<td>Author</td>
<td>F. Dörfler</td>
</tr>
<tr>
<td>Credit</td>
<td>6</td>
</tr>
<tr>
<td>Objective</td>
<td>Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>MATLAB is used for system analysis and simulation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course</th>
<th>Analog Integrated Circuits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>227-0166-AAL</td>
</tr>
<tr>
<td>Title</td>
<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
</tr>
<tr>
<td>Author</td>
<td>Q. Huang</td>
</tr>
<tr>
<td>Credit</td>
<td>6</td>
</tr>
<tr>
<td>Objective</td>
<td>This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.</td>
</tr>
<tr>
<td>Content</td>
<td>This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course</th>
<th>High Voltage Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>227-0117-AAL</td>
</tr>
<tr>
<td>Title</td>
<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
</tr>
<tr>
<td>Author</td>
<td>C. Franck</td>
</tr>
<tr>
<td>Credit</td>
<td>6</td>
</tr>
<tr>
<td>Objective</td>
<td>Understanding of the fundamental phenomena and principles connected with the occurrence of extensive electric field strengths. This knowledge is applied to the dimensioning of high-voltage equipment. Methods of computer-modeling in use today are presented and applied within a workshop in the framework of the exercises. The students know the fundamental phenomena and principles connected with the occurrence of extensive electric field strengths. They comprehend the different mechanisms leading to the failure of insulation systems and are able to apply failure criteria on the dimensioning of high voltage components. They have the ability to identify of weak spots in insulation systems and to name possibilities for improvement. Further they know the different insulation systems and their dimensioning in practice.</td>
</tr>
<tr>
<td>Abstract</td>
<td>These circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems.</td>
</tr>
<tr>
<td>Content</td>
<td>Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits.</td>
</tr>
<tr>
<td>Literature</td>
<td>Handouts of slides. No script but an accompanying textbook is recommended.</td>
</tr>
</tbody>
</table>
**Content**
- discussion of the field equations relevant for high voltage engineering.
- analytical and numerical solutions/solving of this equations, as well as the derivation of the important equivalent circuits for the description of the fields and losses in insulations
- introduction to kinetic theory of gases
- mechanisms of the breakdown in gaseous, liquid and solid insulations, as well as insulation systems
- methods for the mathematical determination of the electric withstand of gaseous, liquid and solid insulations
- application of the expertise on high voltage components
- excursions to manufacturers of high voltage components
- exercise to learn on computer-modeling in high voltage engineering

**Lecture notes**
Handouts

**Literature**

| Electrical Engineering and Information Technology Master - Key for Type |
|---|---|
| O | Compulsory |
| W+ | Eligible for credits and recommended |
| W | Eligible for credits |
| E- | Recommended, not eligible for credits |
| Z | Courses outside the curriculum |
| Dr | Suitable for doctorate |

| Key for Hours |
|---|---|
| V | lecture |
| G | lecture with exercise |
| U | exercise |
| S | seminar |
| K | colloquium |
| P | practical/laboratory course |
| A | independent project |
| D | diploma thesis |
| R | revision course / private study |

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Compulsory core courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1633-00L</td>
<td>Energy Conversion</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>H. G. Park</td>
</tr>
</tbody>
</table>

**Abstract**

Fundamentals of Thermal Sciences in association with Energy Conversion

**Objective**

To become acquainted and familiarized with basic principles of fundamental thermal sciences (Thermodynamics, Heat Transfer, etc.) as well as their linkage to energy conversion technologies.

**Content**

Thermodynamics (first and second laws), Heat Transfer (conduction/convection/radiation), Technical Applications

**Lecture notes**

Slides will be distributed by e-mail every week.

**Literature**

1. Introduction to Thermodynamics and Heat Transfer, 2nd ed. by Cengel, Y. A., McGraw Hill;
2. Fundamentals of Engineering Thermodynamics, 6th ed. by Moran & Shapiro, Wiley

**Prerequisites / notice**

This course is intended for students outside of D-MAVT.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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</tr>
</thead>
<tbody>
<tr>
<td>227-1631-00L</td>
<td>Energy System Analysis</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>G. Hug, S. Hellweg, F. Noembrini, A. Schlüter</td>
</tr>
</tbody>
</table>

**Abstract**

The course provides an introduction to the methods and tools for analysis of energy consumption, energy production and energy flows. Environmental aspects are included as well as economical considerations. Different sectors of the society are discussed, such as electric power, buildings, and transportation. Models for energy system analysis planning are introduced.

**Objective**

The purpose of the course is to give the participants an overview of the methods and tools used for energy systems analysis and how to use these in simple practical examples.

**Content**

The course gives an introduction to methods and tools for analysis of energy consumption, energy production and energy flows. Both larger systems, e.g. countries, and smaller systems, e.g. industries, homes, vehicles, are studied. The tools and methods are applied to various problems during the exercises. Different conventions of energy statistics used are introduced.

The course provides also an introduction to energy systems models for developing scenarios of future energy consumption and production. Bottom-up and Top-Down approaches are addressed and their features and applications discussed.

The course contains the following parts:
- Part I: Energy flows and energy statistics
- Part II: Environmental impacts
- Part III: Electric power systems
- Part IV: Energy in buildings
- Part V: Energy in transportation
- Part VI: Energy systems models

**Lecture notes**

Handouts

**Literature**


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0122-00L</td>
<td>Introduction to Electric Power Transmission: System &amp; Technology</td>
<td>O</td>
<td>6 credits</td>
<td>4G</td>
<td>C. Franck, G. Hug</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction to theory and technology of electric power transmission systems.

**Objective**

At the end of this course, the student will be able to: describe the structure of electric power systems, name the most important components and describe what they are needed for, apply models for transformers and lines, explain the technology of overhead power lines, calculate stationary power flows, current and voltage transients and other basic parameters in simple power systems.

**Content**

Structure of electric power systems, transformer and power line models, analysis of and power flow calculation in basic systems, symmetrical and unsymmetrical three-phase systems, transient current and voltage processes, technology and principle of electric power systems.

**Lecture notes**

Lecture script in English, exercises and sample solutions, translation of important vocabulary: english-german.

### Elective Core Courses

*These courses are particularly recommended, other ETH-courses from the field of Energy Science and Technology at large may be chosen in accordance with your tutor.*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0577-00L</td>
<td>An Introduction to Sustainable Development in the Built Environment</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>G. Habert</td>
</tr>
</tbody>
</table>

**Abstract**

This year the UN Conference in Paris will shape future world objectives to tackle climate change. This course provides an introduction to the notion of sustainable development when applied to our built environment.
Objective
At the end of the semester, the students have an understanding of the term of sustainable development, its history, the current political and scientific discourses and its relevance for our built environment.

In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environmental aspects.

The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.

Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.

After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.

The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.

Content
The following topics give an overview of the themes that are to be worked on during the lecture.

- Overview on the history and emergence of sustainable development
- Overview on the current understanding and definition of sustainable development
- Case Study 1: Sustainable construction, the role of construction industry (national/international)
- Case Study 2: Cities, forms of settlements
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Synthesis 1: Climate Change mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development

Lecture notes
All relevant information will be online available before the lectures. For each lecture slides of the lecture will be provided.

Literature
A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

151-0123-00L Experimental Methods for Engineers W 4 credits 2V+2U T. Rösgen, R. S. Abhari, K. Boulochos, D. J. Norris, H.M. Prasser, A. Steinfeld

Abstract
The course presents an overview of measurement tasks in engineering environments. Different concepts for the acquisition and processing of typical measurement quantities are introduced. Following an initial in-class introduction, laboratory exercises from different application areas (especially in thermofluidics and process engineering) are attended by students in small groups.

Objective
Introduction to various aspects of measurement techniques, with particular emphasis on thermo-fluidic applications.

Understanding of various sensing technologies and analysis procedures.

Exposure to typical experiments, diagnostics hardware, data acquisition and processing.

Study of applications in the laboratory.

Fundamentals of scientific documentation & reporting.

Content
In-class introduction to representative measurement techniques in the research areas of the participating institutes (fluid dynamics, energy technology, process engineering)

Student participation in 8-10 laboratory experiments (study groups of 3-5 students, dependent on the number of course participants and available experiments)

Lab reports for all attended experiments have to be submitted by the study groups.

A final exam evaluates the acquired knowledge individually.

Lecture notes
Presentations, handouts and instructions are provided for each experiment.

Literature


Prerequisites / notice
Basic understanding in the following areas:
- fluid mechanics, thermodynamics, heat and mass transfer
- electrical engineering / electronics
- numerical data analysis and processing (e.g. using MATLAB)

151-0163-00L Nuclear Energy Conversion W 4 credits 2V+1U H.M. Prasser

Abstract
Physical fundamentals of the fission reaction and the sustainable chain reaction, thermal design, construction, function and operation of nuclear reactors and power plants, light water reactors and other reactor types, conversion and breeding

Objective
Students get an overview on energy conversion in nuclear power plants, on construction and function of the most important types of nuclear reactors with special emphasis to light water reactors. They obtain the mathematical/physical basis for quantitative assessments concerning most relevant aspects of design, dynamic behaviour as well as material and energy flows.

Content
Nuclear physics of fission and chain reaction. Thermodynamics of nuclear reactors. Design of the rector core. Introduction into the dynamic behaviour of nuclear reactors. Overview on types of nuclear reactors, difference between thermal reactors and fast breeders. Construction and operation of nuclear power plants with pressurized and boiling water reactors, role and function of the most important safety systems, special features of the energy conversion. Development tendencies of rector technology.

Lecture notes
Hand-outs will be distributed. Additional literature and information on the website of the lab: https://www.ethz.ch/content/specialinterests/mav/energy-technology/lab-of-nuclear-energy-systems/en/studium/teaching-materials/151-0163-00nuclear-energy-conversion.html

Literature

R. L. Murray: Nuclear Energy (Sixth Edition), An Introduction to the Concepts, Systems, and Applications of Nuclear Processes, Elsevier
Abstract
Advanced course in radiation heat transfer

Objective
Fundamentals of radiative heat transfer and its applications. Examples are combustion and solar thermal/thermochemical processes, and other applications in the field of energy conversion and material processing.

Content

Lecture notes
Copy of the slides presented.

Literature

151-0203-00L Turbomachinery Design

Abstract
Introduction to the understanding of a broad range of turbomachinery devices. Learn the steps of turbomachinery design. Understand the principles, and learn the design procedures and the behaviour of turbomachines.

Content

Lecture notes
Lecture notes

Prerequisites / notice

151-0207-00L Theory and Modeling of Reactive Flows

Abstract
The course first reviews the governing equations and combustion chemistry, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic combustion and its coupling with homogeneous combustion are dealt in detail, and turbulent combustion modeling approaches are presented. Available numerical codes will be used for modeling.

Objective
Theory of combustion with numerical applications

Content
The analysis of realistic reactive flow systems necessitates the use of detailed computer models that can be constructed starting from first principles i.e. thermodynamics, fluid mechanics, chemical kinetics, and heat and mass transport. In this course, the focus will be on combustion theory and modeling. The reacting flow governing equations and the combustion chemistry are firstly reviewed, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Heterogeneous (catalytic) combustion, an area of increased importance in the last years, will be dealt in detail along with its coupling with homogeneous combustion. Finally, approaches for the modeling of turbulent combustion will be presented. Available numerical codes will be used to compute the above described phenomena. Familiarity with numerical methods for the solution of partial differential equations is expected.

Lecture notes
Lecture notes

Prerequisites / notice
Handouts
NEW course

151-0216-00L Wind Energy

Abstract
The objective of this course is to introduce the students to the fundamentals, technologies, modern day application, and economics of wind energy. These subjects are introduced through a discussion of the basic principles of wind energy generation and conversion, and a detailed description of the broad range of relevant technical, economic and environmental topics.

Objective
The objective of this course is to introduce the students to the fundamentals, technologies, modern day application, and economics of wind energy.

Content
This mechanical engineering course focuses on the technical aspects of wind turbines; non-technical issues are not within the scope of this technically oriented course. On completion of this course, the student shall be able to conduct the preliminary aerodynamic and structural design of the wind turbine blades. The student shall also be more aware of the broad context of drivetrains, dynamics and control, electrical systems, and meteorology, relevant to all types of wind turbines.

Lecture notes
Lecture notes in English

Literature

151-0251-00L IC-Engines and Propulsion Systems I

Abstract
Number of participants limited to 60.
Introduction to basic concepts, operating maps and work processes of internal combustion engines. Thermodynamic analysis and design, scavenging methods, heat transfer mechanisms, turbulent flow field in combustion chambers, turbocharging. Energy systemic role of IC engines; conventional and electrified vehicle propulsion systems and decentralized power generation.

Objective
The students learn the basic concepts of an internal combustion engine by means of the topics mentioned in the abstract. This knowledge is applied in several calculation exercises and two lab exercises at the engine test bench. The students get an insight in alternative power train systems.

Literature

151-0293-00L Combustion and Reactive Processes in Energy and Materials Technology

Abstract
The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials.

Objective
The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials. The lecture is part of the focus "Energy, Flows & Processes" on the Bachelor level and is recommended as a basis for a future Master in the area of energy. It is also a facultative lecture on Master level in Energy Science and Technology and Process Engineering.

Content

Lecture notes
Lecture notes

Literature
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0567-00L</td>
<td>Engine Systems</td>
<td>W 4</td>
<td>C. Onder</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Introduction to current and future engine systems and their control systems</td>
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<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Introduction to methods of control and optimization of dynamic systems. Application to real engines. Understand the structure and behavior of drive train systems and their quantitative descriptions.</td>
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<td><strong>Content</strong></td>
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<td></td>
<td>Physical description and mathematical models of components and subsystems (mixture formation, load control, supercharging, emissions, drive train components, etc.). Case studies of model-based optimal design and control of engine systems with the goal of minimizing fuel consumption and emissions.</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<tr>
<td></td>
<td>Introduction to Modeling and Control of Internal Combustion Engine Systems</td>
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<tr>
<td>151-0569-00L</td>
<td>Vehicle Propulsion Systems</td>
<td>W 4</td>
<td>C. Onder, P. Elbert</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Introduction to current and future propulsion systems and the electronic control of their longitudinal behavior</td>
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<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Introduction to methods of system optimization and controller design for vehicles. Understanding the structure and working principles of conventional and new propulsion systems. Quantitative descriptions of propulsion systems</td>
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<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Understanding of physical phenomena and mathematical models of components and subsystems (manual, automatic and continuously variable transmissions, energy storage systems, electric drive trains, batteries, hybrid systems, fuel cells, road/wheel interaction, automatic braking systems, etc.). Presentation of mathematical methods, CAE tools and case studies for the model-based design and control of propulsion systems with the goal of minimizing fuel consumption and emissions.</td>
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<td><strong>Lecture notes</strong></td>
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<tr>
<td></td>
<td>Vehicle Propulsion Systems -- Introduction to Modeling and Optimization</td>
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<tr>
<td>227-0247-00L</td>
<td>Power Electronic Systems I</td>
<td>W 6</td>
<td>J. W. Kolar</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Basics of the switching behavior, gate drive and snubber circuits of power semiconductors are discussed. Soft-switching and resonant DC/DC converters are analyzed in detail and high frequency loss mechanisms of magnetic components are explained. Space vector modulation of three-phase inverters is introduced and the main power components are designed for typical industry applications.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>Detailed understanding of the principle of operation and modulation of advanced power electronics converter systems, especially of zero voltage switching and zero current switching non-isolated and isolated DC/DC converter systems and three-phase voltage DC link inverter systems. Furthermore, the course should convey knowledge on the switching frequency related losses of power semiconductors and inductive power components and introduce the concept of space vector calculus which provides a basis for the comprehensive discussion of three-phase PWM converters systems in the lecture Power Electronic Systems II.</td>
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<td></td>
<td><strong>Content</strong></td>
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<td></td>
<td>Basics of the switching behavior and gate drive circuits of power semiconductor devices and auxiliary circuits for minimizing the switching losses are explained. Furthermore, zero voltage switching, zero current switching, and resonant DC/DC converters are discussed in detail; the operating behavior of isolated full-bridge DC/DC converters is detailed for different secondary side rectifier topologies; high frequency loss mechanisms of magnetic components of converter circuits are explained and approximate calculation methods are presented; the concept of space vector calculus for analyzing three-phase systems is introduced; finally, phase-oriented and space vector modulation of three-phase inverter systems are discussed related to voltage DC link inverter systems and the design of the main power components based on analytical calculations is explained.</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td>Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<tr>
<td></td>
<td>Lectures of Dr. Ch. Onder are also possible to be held in German</td>
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</tr>
<tr>
<td>227-0523-00L</td>
<td>Railway Systems I</td>
<td>W 6</td>
<td>M. Meyer</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Basic characteristics of railway vehicles and their interfaces with the railway infrastructure: - Transportation tasks and vehicle types - Running dynamics - Mechanical part of rail vehicles - Brakes - Traction chain and auxiliary supply - Railway power supply - Signalling systems - Traffic control and maintenance</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>- Overview of the technical characteristics of railway systems - Know-how about the design and construction principles of rail vehicles - Interrelationship between different fields of engineering sciences (mechanics, electro and information technology, transport systems) - Understanding tasks and opportunities of engineers working in an environment which has strong economical and political boundaries - Insight into the activities of the railway vehicle industry and railway operators in Switzerland - Motivation of young engineers to start a career in the railway industry or with railway operators</td>
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</tbody>
</table>
Content

1 Einführung:
1.1 Geschichte und Struktur des Bahnsystems
1.2 Fahrdynamik

2 Vollbahnfahrzeuge:
2.3 Mechanik: Kasten, Drehgestelle, Lauftechnik, Adhäsion
2.2 Bremsen
2.3 Traktionsantriebssysteme
2.4 Hilfsbetriebe und Komfortanlagen
2.5 Steuerung und Regelung

3 Infrastruktur:
3.1 Fahrweg
3.2 Bahnstromversorgung
3.3 Sicherungsanlagen

4 Betrieb:
4.1 Interoperabilität, Normen und Zulassung
4.2 RAMS, LCC
4.3 Anwendungsbeispiele

Voraussichtlich ein oder zwei Gastreferate

Geplante Exkursionen:
Betriebszentrale SBB, Zürich Flughafen
Reparatur und Unterhalt, SBB Zürich Altstetten
Fahrzeugfertigung, Stadler Bussnang

Lecture notes
Abgabe der Unterlagen (gegen eine Schutzgebühr) zu Beginn des Semesters. Rechtzeitig eingeschriebene Teilnehmer können die Unterlagen auf Wunsch und gegen eine Zusatzgebühr auch in Farbe beziehen.

Prerequisites / notice
Dozent: Dr. Markus Meyer, Emkamatik GmbH

Voraussichtlich ein oder zwei Gastvorträge von anderen Referenten.

EST I (Herbstsemester) kann als in sich geschlossene einsemestrige Vorlesung besucht werden. EST II (Frühjahrssemester) dient der weiteren Vertiefung der Fahrzeugtechnik und der Integration in die Bahninfrastruktur.

227-0526-00L Power System Analysis W 6 credits 4G G. Hug

Abstract
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Objective
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Content
The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand oriented, operationally, economically), network planning and network operation, models of N-port network components (line, cables, shunts, transformers), the p.u. computation, computer oriented network models, linear networks (solution methods - direct, iterative), algorithms for the solution of non-linear sets of equations, derived from the electrical power system (Newton-Raphson), power flow computation (problem definition, solution methods), three phase short-circuit computation, application of power flow algorithms. Introduction to power system stability.

Lecture notes
Lecture notes. Course is supported by WWW-teaching system.

227-0731-00L Power Market I - Portfolio and Risk Management W 6 credits 4G D. Reichelt, G. A. Koeppe

Abstract
Portfolio and risk management in the electrical power business, Pan-European power market and trading, futures and forward contracts, hedging, options and derivatives, performance indicators for the risk management, modelling of physical assets, cross-border trading, ancillary services, balancing power market, Swiss market model

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of Scenarios for the development of world energy consumption, energy intensity and economic development. Energy conversion chains, Renewable Energy Technologies I Globalization of markets increases global competition and requires enterprises to continuously improve their performance to sustainably survive. Engineers substantially contribute to the success of an enterprise provided they understand and follow fundamental international market forces, economic basics and operational business management.

The goal of the lecture is to get a basic understanding of international market mechanisms and their consequences for a successful enterprise. Students will learn by practical examples how to analyze international markets, competition as well as customer needs and how to convert into a successful portfolio an enterprise offers to the global market. They will understand the basics of international business management, why efficient organizations and effective business processes are crucial for the successful survival of an enterprise and how all this can be implemented.

The first part of the course provides an overview about the development of international markets, the expected challenges and the players in the market. The second part is focusing on the economic aspects of an enterprise, their importance for the long term success and how to effectively manage an international business. Based on these fundamentals the third part of the course explains how an innovative product portfolio of a company can be derived from considering the most important external factors and which consequences in respect of product innovation, competitive product pricing, organization and business processes emerge. Each part of the course includes practical examples to demonstrate the procedure.

International Business Management for Engineers

Abstract
Globalization of markets increases global competition and requires enterprises to continuously improve their performance to sustainably survive. Engineers substantially contribute to the success of an enterprise provided they understand and follow fundamental international market forces, economic basics and operational business management.

Objective
The goal of the lecture is to get a basic understanding of international market mechanisms and their consequences for a successful enterprise. Students will learn by practical examples how to analyze international markets, competition as well as customer needs and how to convert into a successful portfolio an enterprise offers to the global market. They will understand the basics of international business management, why efficient organizations and effective business processes are crucial for the successful survival of an enterprise and how all this can be implemented.

Content
The first part of the course provides an overview about the development of international markets, the expected challenges and the players in the market. The second part is focusing on the economic aspects of an enterprise, their importance for the long term success and how to effectively manage an international business. Based on these fundamentals the third part of the course explains how an innovative product portfolio of a company can be derived from considering the most important external factors and which consequences in respect of product innovation, competitive product pricing, organization and business processes emerge. Each part of the course includes practical examples to demonstrate the procedure.

Lecture notes
A script is provided for this lecture.

Prerequisites / notice
1 excursion per semester, 2 case studies, guest speakers for specific topics. Course Moodle: https://moodle-app2.let.ethz.ch/course/view.php?id=2196

Renewable Energy Technologies I

Abstract
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry), Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content

Lecture notes
Lecture notes will be distributed electronically during the course.

Literature

Prerequisites / notice
Fundamentals of chemistry, physics and thermodynamics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.
This course has the aim of deepening students’ knowledge of the environmental assessment methodologies and their various applications. Technical systems are investigated in projects, based on the software and tools introduced in the course 102-0317-03L Advanced Env. Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.

**Objective**

- Ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- Knowledge about the current state of the scientific discussion and new research developments
- Ability to properly plan, conduct and interpret environmental assessment studies
- Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers

**Content**

- Inventory developments, transparency, data quality, data completeness, and data exchange formats
- Allocation (multioptput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Recent development in impact assessment
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Uncertainty analysis
- Subjectivity in environmental assessments
- Multicriteria analysis
- Case Studies

**Prerequisites / notice**

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done classwork in this topic before are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. 2016: Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).

**Literature**

Lecture notes

No script. Lecture slides and literature will be made available on the lecture homepage.

**Prerequisites / notice**

Technical systems are investigated in projects, based on the software and tools introduced in the course 102-0317-03L Advanced Env. Assessment (Computer Lab I). The projects are created around a complete but simplified LCA study, where the students will learn how to answer a given question with target oriented methodologies using various software programs and data sources for env. assessment and how to address the challenges when analyzing a complex system with available data and software limitations.

**Objective**

Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.

**Prerequisites / notice**

Not for master students in Environmental Engineering choosing module Ecological Systems Design as already included in Environment and Computer Laboratory I (Year II) as well as already included in Environment and Computer Laboratory I (Year Course): 102-0527-00 and 102-0528-00.

**Abstract**

How to make sustainability operational - in industry, services and other organizations: You will learn how to put sustainability into practice by integrating environmental, social and economic aspects into organisations' management and processes. The course contains both a management view, as well as a sustainability view - and how to combine them.

**content**

We meet for five 3-hour-lectures, with discussions and case studies during course time. Additionally, small case studies in-between courses will be given at most course days.

- Sustainable Development and its meaning for Management
- Management Standards for Sustainability (ISO and others)
- Sustainability Opportunities and Innovation
- Organisation and Implementation
- The concept of 'Continuous Improvement'
- Environmental Performance Measurement (Concepts, Standards, Methods)
- Life Cycle Costing, Life Cycle Management
- (Sustainable) Supply Chain Management
- Communication of Sustainability Issues

**Lecture notes**

Course documentation as well as case study descriptions will be provided during the course via the "ilias" repository.
This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a Generic modeling approaches for control-oriented models based on first principles, Lagrangian formalism and experimental data. Model System Modeling

An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments. System Modeling

Introduction to system modeling for control. Parameter identification. Analysis of linear and nonlinear systems. Case studies. The exercises address practical examples. One larger case study is to be solved.

The exercises address practical examples. One larger case study is to be solved.

Prerequisites / notice

If you have specific interests or questions, let me know at arthurb@ethz.ch. Maybe I can include your issues - or I can't :-)

Literature

There are two ways to approach the course's issues:


c) We will touch upon the hotel sustainable scheme and label "ibex" see: http://www.e2mc.com/images/stories/e2_bilder/downloads/Umweltfocus_d.pdf (for an english version, pls contact the lecturer at arthurb@ethz.ch)

Prerequisites:

Control Systems I and Informatics I. - Introduction to rapid prototyping
- System dynamics and virtual worlds with haptic feedback
- Timer interrupts to create sampling time intervals
- Pulse width modulation
- Quadrature decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Digital I/O and serial communication
- Application of C-programming on a microprocessor

Subjects covered in lectures and practical lab exercises include:

- Application of C-programming on a microprocessor
- Digital I/O and serial communication
- Quadrature decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Pulse width modulation
- Timer interrupts to create sampling time intervals
- System dynamics and virtual worlds with haptic feedback
- Introduction to rapid prototyping

This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: marischm@ethz.ch)

Detailed information can be found on the course website http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html

Prerequisites are Control Systems I and Informatics I.

This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: marischm@ethz.ch)

After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

Detailed information can be found on the course website http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html

The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Rate-Controlled Separations in Fine Chemistry

Prerequisites are Control Systems I and Informatics I.
Objective
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Content
The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

Lecture notes
Handouts during the class

Literature
Recommendations for text books will be covered in the class

Prerequisites / notice
Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

151-0951-00L

Objective
Process design and safety deals with the fundamentals of process apparatus, plant design and safety.

Content
The goal of the lecture is to expound design characteristics of systems for process engineering applications.

Lecture notes
Script is available, english slides will be distributed

Literature

363-0387-00L

Objective
The lectures addresses the assessment of corporate sustainability and its links to strategy, technology, and finance. Students learn why sustainability matters for managers and how businesses can act towards it. E-modules allow students to train critical thinking skills. In the 2nd half of the semester, sustainability challenges on water, energy, mobility, and food are explored in group projects.

Content
Develop critical thinking skills (argumentation, communication, evaluative judgment) that are useful in the context of corporate sustainability using an innovative writing and peer review method.

Lecture notes
Presentation slides will be made available on moodle prior to lectures.

Literature
Literature recommendations will be distributed during the lecture

363-0357-00L

Objective
Understanding the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Content
Introduction to resource and environmental economics
Importance of resource and environmental economics
Main issues of resource and environmental economics
Normative basis
Utilitarianism
Fairness according to Rawls
Economic growth and environment
Externalities in the environmental sphere
Governmental internalisation of externalities
Private internalisation of externalities: the Coase theorem
Free rider problem and public goods
Types of public policy
Efficient level of pollution
Tax vs. permits
Command and Control Instruments
Empirical data on non-renewable natural resources
Optimal price development: the Hotelling-rule
Effects of exploration and Backstop-technology
Effects of different types of markets.
Biological growth function
Optimal depletion of renewable resources
Social inefficiency as result of over-use of open-access resources
Cost-benefit analysis and the environment
Measuring environmental benefit
Measuring costs
Concept of sustainability
Technological feasibility
Conflicts sustainability / optimality
Indicators of sustainability
Problem of climate change
Cost and benefit of climate change
Climate change as international ecological externality
International climate policy: Kyoto protocol
Implementation of the Kyoto protocol in Switzerland

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 547 of 1571
This course aims to develop the competency of chemical engineers in process flowsheeting and simulation. Specifically, students will gain knowledge about:

- Deep understanding of chemical engineering fundamentals: the acquisition of new concepts and the application of previous knowledge in the area of chemical process systems and their mechanisms are crucial to intelligently simulate and evaluate processes.
- Modelling of general chemical processes and systems: students have to be able to identify the boundaries of the system to be studied and develop the set of relevant mathematical relations, which describe the process behavior.
- Mathematical reasoning and computational skills: the familiarization with mathematical algorithms and computational tools is essential to be capable of achieving rapid and reliable solutions to simulation and optimization problems. Hence, students will learn the mathematical principles necessary for process simulation and optimization, as well as the structure and application of process simulation software. Thus, they will be able to develop criteria to correctly use commercial software packages and critically evaluate their results.

**Process simulation and flowsheeting**

- Definition and fundamentals
- Classification: stationary (steady-state) versus dynamic (transient state) systems
- Fields of application
- Case studies

**Process modeling**

- Modeling strategies of process systems
- Mass conservation
- Species balance
- Energy conservation
- Momentum balance
- Multiphase-systems: equilibrium & non-equilibrium models
- Process system model

**Process simulation**

- Process specification
- Introduction to process specification
- Classification of mathematical models: AMS, DOE, DAE, PDE
- Model validation
- Software tools
- Solution methods for process flowsheeting
- Simultaneous methods
- Sequential methods
- Dynamic simulation
- Numerical solution: explicit and implicit methods
- Continuous-discrete simulation: handling of discontinuities

**Process optimization and analysis**

- Classification of optimization problems
- Linear programming
- Non-linear programming
- Dynamic programming
- Optimization methods in process flowsheeting
- Sequential methods
- Simultaneous methods

**Commercial software for simulation: Aspen Plus**

- Thermodynamic property methods
- Reaction and reactors
- Separation / columns
- Convergence & debugging

**Literature**

An exemplary literature list is provided below:


Prerequisites / notice

A basic understanding of material and energy balances, thermodynamic property methods and typical unit operations (e.g., reactors, flash separations, distillation/absorption columns etc.) is required.
Content
- Vorstellung der Dozierenden mit Fallstudie aus der persönlichen Berufspraaxis (CH, RK, WL, FS)
- Resourcen der Welt und Bedeutung für die Schweiz (RK)
- Metallische Erzlagertätten - Einführung (CH)
- Metallische Erzlagertätten - Magmatische Prozesse Test 1 (CH)
- Geowissenschaftliche Grundlagen für die Dynamische Erde (CH)
- Geowissenschaftliche Grundlagen für die Dynamische Erde (CH)
- Metallische Erzlagertätten - Magmatisch-hydrothermal Systeme Test 2 (CH)
- Energierechtstoffe - Einführung: Bildungsprozesse Petroleum und Erdgas (WL)
- Energierechtstoffe - Kohle und CO2-Entsorgung Test 3 (WL/RK)
- Nichtmetallische Rohstoffe - Baustoffe (RK)
- Nichtmetallische Rohstoffe - Erden (RK/FS)
- Nichtmetallische Rohstoffe - Industriematerialien Test 4 (FS)
- Industriematerialien und nachhaltige Nutzung von Rohstoffen der Erde (FS)

Lecture notes
Kursnotizen werden in den Stunden verteilt

Literature

Prerequisites / notice
Geologische und mineralogische Grundkenntnisse aus Dynamische Erde I und II einschließlich Uebungen in Gesteinsbestimmung; Buch von Grotzinger, Press & Siever. Anwesenheit in den Stunden ist essentiell -- Uebungen und 4 Kurzfrufungen zur Leistungskontrolle.

701-0963-00L Energy and Mobility

Abstract
The lecture Energy and Mobility imparts profound knowledge on how to reduce energy in mobility systems. Both Engineering science and social science aspects are integrated, as technological potentials, policy tools, and human decision making behaviour are combined in order to assess how to reduce energy demand for transport.

Objective
The main objectives of this lecture are:
(i) Students gain profound knowledge on how to frame problems related to the reduction of energy demand (or greenhouse gas emissions) of mobility (sub-)systems.
(ii) Students have an overview on the most relevant technological potentials (fuel-based and vehicle-based).
(iii) Students can assess whether a given reduction goal is ambitious or not, and whether given policy tools are adequate to reach the defined reduction goal.

Content
The lecture deals with the intersection of energy and transport with focus on motorized individual transport.

- Trends and Targets: Analysis of current trends in the mobility sector, establishment of a trend scenario (baseline scenario), Definition of the reduction targets (expressed in terms of energy demand or greenhouse gas emissions; base year and target year; absolute or relative reduction target)
- Potential Analysis: Analysis of currently employed technologies and of upcoming technologies. Identification of the reduction potential of current, conventional technologies and of future, alternative technologies. Technologies cover both the fuel and the vehicle side.
- Policy Measures: Possible policy measures, direct, indirect and macro-level effects of policies, psychological aspects of decision making, elements of behavioral economics and prospect theory, combination of policies into policy mixes.
- Effects and Side Effects: Forecasting the effects of policy measures, differentiation between effects that can be quantified and those that cannot. Identification of unintended (side) counter-effects like rebound effects and perverse incentives.

Multidisciplinary Courses
With the consent of the tutor, the students are free to choose individually from the entire course offer of ETH Zürich.

Course Catalogue of ETH Zurich

Semester Project
Number
227-1101-00L

Title
How to Write Scientific Texts in Engineering Sciences

Type
E-Students recommended prerequisite for Semester Projects and Master Theses at D-ITET (MSc BME, MSc EEIT, MSc EST).

ECTS
0 credits

Hours
J. Leuthold

Lecturers

Abstract
The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training.

The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

Objective
Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

Content
* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the Art, the "in this paper" paragraph, the scientific part, the summary, Equations, Figures).

* Topic 2: Power Point Presentations.

* Topic 3: Citation Rules and Citation Software.

* Topic 4: Guidelines for Research Integrity.

Literature
ETH "Citation Etiquette", see www.plagiate.ethz.ch.


Prerequisites / notice
Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

Semester Project
Registration in mystudies required!

Abstract
The semester project is designed to train the students in solving specific problems from the field of Energy Science & Technology. This project uses the technical and social skills acquired during the master's program. The semester project ist advised by a professor and must be approved in advance by the tutor.
## Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1650-00L</td>
<td>Internship in Industry</td>
<td>O</td>
<td>8</td>
<td>external organisers</td>
<td></td>
</tr>
</tbody>
</table>

**Objective**
see above

**Abstract**
The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

**Objective**
see above

## GESS Science in Perspective

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses

ETH/UZH

**Recommended GESS Science in Perspective (Type B) for D-ITET**

## Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences</td>
<td>E-</td>
<td>0</td>
<td>J. Leuthold</td>
<td></td>
</tr>
</tbody>
</table>

**Objective**
Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

**Content**
- * Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the Art, the “in this paper” paragraph, the scientific part, the summary, Equations, Figures).
- * Topic 3: Citation Rules and Citation Software.
- * Topic 4: Guidelines for Research Integrity.

**Literature**
ETH "Citation Etiquette", see www plagiate.ethz.ch.
ETH Guidelines on "Guidelines for Research Integrity", see www ee.ethz.ch > Education > > Contacts, links & documents > Forms and documents > Brochures / guides.

**Prerequisites / notice**
Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1601-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>40D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

**Abstract**
The master program in Energy Science and Technology culminates in a six months research project which addresses a scientific research questions on one's chosen area of specialization. The masters thesis is supervised by a program-affiliated faculty member and the topic must be approved in advance by the tutor.

**Objective**
see above

---

### Energy Science and Technology Master - Key for Type

<table>
<thead>
<tr>
<th>W</th>
<th>Eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
</tbody>
</table>

| Dr | Suitable for doctorate |
| O  | Compulsory |
| W+ | Eligible for credits and recommended |

### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
</tbody>
</table>

| P | practical/laboratory course |
| A | independent project |
| D | diploma thesis |
| R | revision course / private study |

### ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Earth Sciences Bachelor

Bachelor Studies (Programme Regulations 2016)

1. Semester

First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-2001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>W. Uhlig, J. E. E. Buschmann, S. Canonica, P. Funck, E. C. Meister, R. Verel</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>General Chemistry I: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.</td>
</tr>
</tbody>
</table>
|         | Content                   |      |         |         | 1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria) |

| 401-0251-00L | Mathematics I          | O    | 6 credits | 4V+2U   | A. Cannas da Silva |
|              | Abstract                |      |           |         | This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations. |
|              | Objective               |      |           |         | Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment. |
|              |                         |      |           |         | 2. Linear Algebra and Complex Numbers: systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra. |
|              |                         |      |           |         | 3. Ordinary Differential Equations: separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems. |
|            |                        |      |           |         | - Bretscher, O.: 'Linear Algebra with Applications (Pearson Prentice Hall). |

| 651-3001-00L | Dynamic Earth I        | O    | 6 credits | 4V+2U   | G. Bernasconi-Green, E. Kissling, O. Bachmann, T. Kraft, M. Lupker, M. Schönbächler, S. Willett |
|             | Abstract               |      |           |         | Provides a basic introduction into Earth Sciences, emphasizing different rock-types and the geological rock-cycle, as well as introduction into geophysics and plate tectonic theory. |
|             | Objective              |      |           |         | Understanding basic geological and geophysical processes. |
|             | Content                |      |           |         | Overview of the Earth as a system, with emphasis on plate tectonic theory and the geological rock-cycle. Provides a basic introduction to crystals and minerals and different rock-types. Lectures include processes in the Earth’s interior, physics of the earth, planetology, introduction to magmatic, metamorphic and sedimentary rocks. Exercises are conducted in small groups to provide more in depth understanding of concepts and content of the lectures. |

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0030-00L</td>
<td>Laboratory Course: Elementary Chemical Techniques</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>N. Kober, M. Morbidelli, M. H. Schrott, B. Wehrli</td>
</tr>
</tbody>
</table>
Abstract
This practical course provides an introduction to elementary laboratory techniques. The experiments cover a wide range of techniques, including analytical and synthetic techniques (e.g. investigation of soil and water samples or the preparation of simple compounds). Furthermore, the handling of gaseous substances is practised.

Objective
This course is intended to provide an overview of experimental chemical methods. The handling of chemicals and proper laboratory techniques represent the main learning target. Furthermore, the description and recording of laboratory processes is an essential part of this course.

Content
The classification and analysis of natural and artificial compounds is a key subject of this course. It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks:

- Selected samples (e.g. soil and water) will be analysed with various methods, such as titrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvatisation or precipitation processes) is studied.
- The synthesis of simple inorganic complexes or organic molecules is practised.
- Furthermore, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.

Lecture notes
The script will be published on the web. Details will be provided on the first day of the semester.

Literature
A thorough study of all script materials is requested before the course starts.

>>> General Courses in Earth Sciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-3301-00L</td>
<td>Crystals and Minerals</td>
<td></td>
<td>4 credits</td>
<td>2V+1.5U</td>
<td>P. Brack, E. Reusser</td>
</tr>
</tbody>
</table>

Abstract
To understand, qualitatively and semi-quantitatively, crystal and mineral formation, the interdependence between crystals structure, chemical composition and physical properties. This dependence is especially the case for the structural dependence of optical anisotropy and the elastic properties of the minerals as well as for the growth of crystals and their defect structures.

Objective
Qualitatives und teilweise quantitatives Verständnis für den Aufbau von Kristallen und Mineralien, für die Zusammenhänge zwischen chemischer Zusammensetzung, Kristallstruktur und physikalischen Eigenschaften, für das Wachstum von Kristallen sowie wichtiger identifikationsrelevant makroskopischer Eigenschaffen; selbständige Identifikation der rund 70 wichtigsten Mineralarten.

Content
- Symmetrien und Ordnung, Punktgruppen, Translationsgruppen, Raumgruppen.
- einfache Strukturtypen, dichte Kugelpackungen, Strukturbestimmende Faktoren.
- chemische Bindungen, Beziehungen zwischen Struktur und Eigenschaften einer Kristall.
- Grundlagen von Thermodynamik und Computersimulationen in der Kristallographie.
- Einführung in die Mineralogie und Mineralsystematik.
- Praktikum in Mineralbestimmen aufgrund makroskopischer Eigenschaften.

Literature

651-4143-00L | Geobiology                  | O    | 3 credits | 2V  | T. I. Eglinton |

Abstract
We will study traces in the lithosphere that have been left behind by organisms in the course of Earth history and mineral components, which were built through biological processes or used as sources of energy and nutrients. Traces of life from the past will be compared with the development of the diversity of and the disparities in today’s organisms.

Objective
The course will allow students to ask questions about the origin and the evolution of life on Earth, to understand contemporary hypotheses and create new methods of developing them further. Theory is supplemented with observations in the field, exercises and the application of simple mathematical models. The course will enable students to integrate geobiological knowledge into topics that will be taught in subsequent Earth science courses and into the current understanding of Earth history. They will learn to better understand modern geological settings and, if necessary, to recommend biogeochemically well-founded and responsible interventions or protective measures.

Content
- how biological cells and its components are built from essential elements and molecules,
- where the elements and molecules needed to form biomass originate,
- how cells function and which life styles organisms developed,
- where organisms can exist and which factors select for their presence,
- where biologically useful forms of energy come from and under which conditions they can be exploited,
- how one can apply thermodynamic principles to predict the stability, metabolic principles to predict the stability, metabolic pathways and biogeochemical processes,
- how organic and inorganic monomers can polymerise to form biomacromolecules and how these can be broken down again,
- how biomacromolecules can acquire catalytic abilities,
- which metabolic strategies lead to the selection of molecular isomers,
- how biological metabolism can change environmental conditions and composition,
- which metabolic products can lead to mineralogical signals in the rock record,
- how biomolecules and elements are altered in sedimentary deposits,
- which biological skeletal components can become indicators in Earth history,
- how organic and inorganic components and redox-labile trace elements are cycled in the biosphere,
- how biogeochemical cycles function and how they can get out of steady state,
- which information of relevance for Earth history is stored in genomes of organisms,
- how biological “innovations” evolved, how they were maintained over time and how they changed in response to environmental changes,
- which characteristics were essential for an ancestral cell to be able to metabolise, to reproduce and to respond to changes in environmental conditions,
- which abiotic, catalytic processes, reactivities on mineral surfaces and conditions were necessary for life to emerge?

Applied Case Studies, which supplement and illustrate the contents:
- Scientific applications of geobiological knowledge are found in fields like Microbial Ecology, Geochemistry, Palaeontology, Sedimentology, Petrology, Ocean Research, Environmental Sciences, Astrobiology and Archaeology.
- Practical applications of geobiological knowledge are needed in fields like soil and water repositories, monitoring groundwater resources, sewage treatment, exploitation of and prospecting for fossil carbon sources, soil remediation, mineral exploration and leaching, forensic and geomedicine.

Lecture notes
Lecture slides, a list with recommended text books, scientific articles and recorded lectures to specific topics will be available in electronic form on the learning management site OLAT. Access requires that participants who are enrolled in MyStudies, will login to the course "Geobiology ETHZ" in OLAT via the switch aai authorisation system.

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 552 of 1571
The central aim is to provide an individual experience of the physical phenomena and the basic principles of the experiment. By conducting the experiments, E. Reusser aims to help students understand the concepts and tools of scientific data analysis.

**Objective**

The following concepts are introduced in the course:
- Effective data analysis and visualisation in 2D and 3D
- Working with matrices and arrays
- Programming and development of algorithms
- Learning to effectively use animations
- Statistical description of a dataset
- Interactive data-mining
- Uncertainty, error propagation and bootstrapping
- Regression analysis
- Testing hypotheses

**Content**

Fehlerrechnung. 9 ausgewählte Versuche zu folgenden Themen:

- Testing hypotheses
- Regression analysis
- Uncertainty, error propagation and bootstrapping
- Interactive data-mining
- Various measuring techniques
- The analysis or measurement errors,
- The interpretation of the measured quantities.

**Literature**

Andrew Putnis.

1. Praktikum in Mineralbestimmen aufgrund makroskopischer identifikationsrelevanter makroskopischer Eigenschaften; selbständige Identifikation der rund 70 wichtigsten Mineralarten.
2. Einführung in die Kristallographie, Verlag Technik GmbH Berlin.

**Recommended Science in Perspective (Type A) for D-ERDW**

**see Science in Perspective: Language Courses ETH/UZH**

**Bachelor Studies (Programme Regulations 2010)**

**3. Semester**

**Compulsory Basic Courses II**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-3591-01L</td>
<td>Laboratory Course in Earth Sciences</td>
<td>O</td>
<td>2 credits</td>
<td>4P</td>
<td>A. Biland, M. Doebeli, M. Männich</td>
</tr>
</tbody>
</table>

**Abstract**

The central aim is to provide an individual experience of the physical phenomena and the basic principles of the experiment. By conducting simple physical experiments the student will learn how to properly use physical instruments and how to evaluate the results correctly.

**Objective**

This laboratory course aims to provide basic knowledge of:

- The setup of a physics experiment,
- The use of measurement instruments,
- Various measuring techniques,
- The analysis or measurement errors,
- The interpretation of the measured quantities.

**Content**

Fehlerrechnung. 9 ausgewählte Versuche zu folgenden Themen:

- Testing hypotheses
- Regression analysis
- Uncertainty, error propagation and bootstrapping
- Interactive data-mining
- Various measuring techniques
- The analysis or measurement errors,
- The interpretation of the measured quantities.

**Literature**

Andrew Putnis.

4. Hans-Rudolf Wenk, Andrei Bulakh

**General Courses in Earth Sciences**

The general courses in Earth Sciences are offered in the 3rd and 4th semester. Out of 40 offered credits, 35 credits have to be acquired.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>651-3301-00L</td>
<td>Crystals and Minerals</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1.5U</td>
<td>P. Brack, E. Reusser</td>
</tr>
</tbody>
</table>

**Abstract**

To understand, qualitatively and semi-quantitatively, crystal and mineral formation, the interdependence between crystals structure, chemical composition and physical properties. This dependence is especially the case for the structural dependence of optical anisotropy and the elastic properties of the minerals as well as for the growth of crystals and their defect structures.

**Objective**

Qualitatives und teilweise quantitatives Verständnis für den Aufbau von Kristallen und Mineralien, für die Zusammenhänge zwischen chemischem Zusammensetzung, Kristallstruktur und physikalischen Eigenschaften, für das Wachstum von Kristallen sowie wichtiger identifikationsrelevanten makroskopischer Eigenschaften; selbständige Identifikation der rund 70 wichtigsten Mineralarten.

**Content**

- Qualitative and semi-quantitative understanding of crystal and mineral formation, the interdependence between crystals structure, chemical composition and physical properties. This dependence is especially the case for the structural dependence of optical anisotropy and the elastic properties of the minerals as well as for the growth of crystals and their defect structures.
- Various measuring techniques
- The analysis or measurement errors,
- The interpretation of the measured quantities.

**Literature**

- Hans-Rudolf Wenk, Andrei Bulakh

**Interpretation of Geological Maps I**

Only for Earth Sciences BSc (Programme Regulations 2010)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>651-3321-00L</td>
<td>Interpretation of Geological Maps I</td>
<td>W</td>
<td>2 credits</td>
<td>2P</td>
<td>M. Frehner</td>
</tr>
</tbody>
</table>

**Abstract**

To understand, qualitatively and semi-quantitatively, crystal and mineral formation, the interdependence between crystals structure, chemical composition and physical properties. This dependence is especially the case for the structural dependence of optical anisotropy and the elastic properties of the minerals as well as for the growth of crystals and their defect structures.

**Objective**

Qualitatives und teilweise quantitatives Verständnis für den Aufbau von Kristallen und Mineralien, für die Zusammenhänge zwischen chemischem Zusammensetzung, Kristallstruktur und physikalischen Eigenschaften, für das Wachstum von Kristallen sowie wichtiger identifikationsrelevanten makroskopischer Eigenschaften; selbständige Identifikation der rund 70 wichtigsten Mineralarten.

**Content**

- Qualitative and semi-quantitative understanding of crystal and mineral formation, the interdependence between crystals structure, chemical composition and physical properties. This dependence is especially the case for the structural dependence of optical anisotropy and the elastic properties of the minerals as well as for the growth of crystals and their defect structures.
- Various measuring techniques
- The analysis or measurement errors,
- The interpretation of the measured quantities.

**Literature**

Andrew Putnis.

4. Hans-Rudolf Wenk, Andrei Bulakh
Abstract
Introduction to reading and construction of simple geologic maps.
Construction of geological cross-sections.
Introduction to Lambert projection and Schmidt net (i.e., stereoplots).

This course is mainly a hands-on-training, where students solve exercises under supervision.

Objective
To improve the ability to understand geological structures in three dimensions and visualize them.

Learn how to read and interpret geological maps, as well as drawing geological cross-sections.

Content
strike lines, symbols
true and apparent thickness of geological units
true and apparent dip
V-rule
3-Point-Problems
unconformities
faults
introduction to the Lambert projection
folds
magentic structures

Lecture notes
Exercises and instructions are handed out and are available online in Moodle.

Literature
Semester literature can be found in the ERDW-library.

Prerequisites / notice
This course is not a prerequisite, but nevertheless extremely helpful for the Terrainkurs II.

651-3323-00L Earth and Climate History W+ 3 credits 2G G. Haug
Course will no longer take place after HS16.

Abstract
The goal of the course is to give the students a perception of the major aspects of planetary history and to add to their curiosity about methods which can be applied in the investigations of more specific problems and to planetary features.

Objective

Content
Frühe Geschichte der Erde, der Litho-, Atmo- und Biosphäre; Phanerozoische Platten und Terranes; Entwicklung des Lebens im Phanerozoikum, Mesozoische Anoxia, Kreide-Tertiär-Grenze, Tertiäre Abkühlung, Messian-Salinitätskrise, Hominidenentwicklung, Quartäre Klimaschwankungen.

Lecture notes
Unterlagen werden abgegeben.

Literature

Examination Blocks

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>402-0063-00L</td>
<td>Physics II</td>
<td>O</td>
<td>5 credits</td>
<td>3V+1U</td>
<td>A. Vaterlaus</td>
</tr>
</tbody>
</table>

Abstract
Introduction to the "way of thinking" and the methodology in Physics, with the help of demonstration experiments. The Chapters treated are Electromagnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena. Whenever possible, examples relevant to the students' main field of study are given.

Objective
Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.

Content
Elektromagnetismus, Elektromagnetische Wellen, Wellenoptik, Quantenoptik, Quantenmechanik, Thermische Eigenschaften, Transportphänomene, Wärmestrahlung

Lecture notes
Skript wird verteilt.

Literature
Friedhelm Kuypers
Physik für Ingenieure und Naturwissenschaftler
Band 2 Elektrizität, Optik, Wellen
Wiley-VCH, 2012
ISBN 3527411445, 9783527411443

Douglas C. Giancoli
Physik
3. erweiterte Auflage
Pearson Studium

Hans J. Paus
Physik in Experimenten und Beispielen
Carl Hanser Verlag, München, 2002, 1068 S.

Paul A. Tipler
Physik
Spektrum Akademischer Verlag, 1998, 1522 S., ca Fr. 120.-

David Halliday Robert Resnick Jearl Walker
Physik
Wiley-VCH, 2003, 1388 S., Fr. 87.- (bis 31.12.03)
dazu gratis Online Ressourcen (z.B. Simulationen): www.halliday.de

651-3341-00L Lithosphere O 3 credits 2V S. Wiemer, E. Kissling
Prerequisite: successful completion of Dynamic Earth I and II is mandatory.

Course will no longer take place after HS16.
Abstract
Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth. Understanding principles of theoretical and experimental geothermics and fundamentals of mantle and lithosphere rheologies.

Objective
Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth. Understanding principles of theoretical and experimental geothermics and fundamentals of mantle and lithosphere rheologies.

Content

Lecture notes
Detailed scriptum in digital form and additional learning modules (www.lead.ethz.ch) available on intranet.

Literature
see list in scriptum.

701-0023-00L
Atmosphere
O
3 credits
2V
H. Wernli, E. M. Fischer, T. Peter

Abstract
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Objective
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

Content
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Lecture notes
Written information will be supplied.

Literature

----- Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0071-00L</td>
<td>Mathematics III: Systems Analysis</td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>N. Gruber, D. Byrne</td>
</tr>
</tbody>
</table>

Abstract
The objective of the systems analysis course is to deepen and illustrate the mathematical concepts on the basis of a series of very concrete examples. Topics covered include: linear box models with one or several variables, non-linear box models with one or several variables, time-discrete models, and continuous models in time and space.

Objective
Learning and applying of concepts (models) and quantitative methods to address concrete problems of environmental relevance. Understanding and applying the systems-analytic approach, i.e., Recognizing the core of the problem - simplification - quantitative approach - prediction.

Content
http://www.up.ethz.ch/education/systems-analysis.html

Lecture notes
Overhead slides will be made available through Ilias.

Literature

701-0401-00L
Hydrosphere
O
3 credits
2V
R. Kipfer, C. Roques

Abstract
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Objective
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Content
Topics of the course.
- Physical properties of water (i.e. density and equation of state)
- Global water resources
- Exchange at boundaries
- Energy (thermal & kinetic), gas exchange
- Mixing and transport processes in open waters
- Vertical stratification, large scale transport
- Turbulence and mixing
- Mixing and exchange processes in rivers
- Groundwater and its dynamics
- Ground water as part of the terrestrial water cycle
- Ground water hydraulics, Darcy's law
- Aquifers and their properties
- Hydrochemistry and tracer
- Ground water use
- Case studies
- 1. Water as resource. 2. Water and climate

Lecture notes
In addition to the suggested literature handouts are distributed.

Literature
Suggested literature.
- Park, Ch., 2001. The Environment, Routledge, 2001

Prerequisites / notice
The case studies and the analysis of the questions and problems are integral part of the course.

5. Semester Majors

Major in Geology

Advisor of the major in Geology is Prof. Stefano Bernasconi

Major in Geology: Core Courses

From the offered core courses in autumn and spring semester, 27 credits have to be acquired.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-3501-00L</td>
<td>Isotope Geochemistry and Isotope Geology</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>S. Bernasconi, D. Vance</td>
</tr>
</tbody>
</table>

Abstract
The course focuses on the most important systems of radioactive and stable isotopes used in geochemistry and geology. Applications of isotope geochemistry for solving fundamental geological problems are discussed on the basis of case studies.

Objective
Development of a basic knowledge and understanding of the applications of the most important systems of stable and radiogenic isotopes.
Content

The following methods will be discussed in detail: the radioactive-radiogenic systems Rb-Sr, Sm-Nd, U-Th-Pb and K-Ar, as well as the stable isotope systems of oxygen, carbon, nitrogen, sulfur and hydrogen.

We will discuss how these methods are used in the following research fields: geochemistry of the earth, age dating, paleotemperature reconstructions, evolution of the crust and mantle reservoirs, sediment diagenesis, fluid rock interactions, hydrothermal activity, paleoceanography, biogeochemical cycles.

Lecture notes

Available

Literature

- Dickin A. P., Radiogenic Isotope Geology, (2005), Cambridge University Press

Prerequisites / notice

Geochemie I: (Bachelor course)

651-3503-00L Metamorphism W+ 3 credits 3G M. W. Schmidt

Abstract

Understanding of the principles governing (chemical) reactions in metamorphic processes and resulting (physical) properties of metamorphic rocks s.l.. Recognition of metamorphic minerals and rocks (e.g. Gesteinsbestimmung)

651-3505-00L Mineral Resources W+ 3 credits 2V C. A. Heinrich, R. Kündig, W. Leu, F. Schenker

Abstract

Overview of the geological formation processes and the global distribution of mineral resources (metals, energy resources, bulk materials and industrial minerals), their economic importance, as well as the political and environmental aspects of responsible resource extraction and site rehabilitation.

Objective


Content

- Vorstreckung der Dozierenden mit Fallstudien aus der persönlichen Berufspraxis (CH, RK, WL, FS)
- Ressourcen der Welt und Bedeutung für die Schweiz (RK)
- Metallische Erzlagerstätten - Einführung (CH)
- Metallische Erzlagerstätten - Magmatische Prozesse Test 1 (CH)
- Ozeanische Hydrothermalsysteme, Oberflächenerz und Atmosphärenentwicklung (CH)
- Metallische Erzlagerstätten - Magmatisch-hydrothermale Systeme Test 2 (CH)
- Energierohstoffe - Einführung; Bildungsprozesse Petroleum und Erdgas (WL)
- Energierohstoffe - Ol und Gas (WL)
- Energierohstoffe - Kohle und CO2-Entsorgung Test 3 (WL/RK)
- Nichtmetallische Rohstoffe - Baustoffe (RK)
- Nichtmetallische Rohstoffe - Erden (RK/FS)
- Nichtmetallische Rohstoffe - Industrieminen Test 4 (FS)
- Industrieminen und nachhaltige Nutzung von Rohstoffen der Erde (FS)

Lecture notes

Kursnotizen werden in den Stunden verteilt

Literature


651-3521-00L Tectonics W+ 3 credits 2V J.P. Burg, E. Kissling

Abstract

Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

Objective

Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Assessment of mechanisms responsible for plate movements (the Earth as a heat transfer machine, dynamics of earth mantle, plate driving forces) and subsequent large-scale structures (oceanic basins and cycle of the oceanic lithosphere, convergence and mountain systems and continual growth, etc) through theoretical and experimental information. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

Content

- Plate tectonic frame work: earth cooling and mantle-plate interaction, three kinds of plate boundaries and their roles and characteristics, cycle of oceanic lithosphere, lifogility and growth of continents, supercontinents.
- Rheology of layered lithosphere and upper mantle.
- Oduction systems
- Collisions systems
- Extensional systems
- Basal evolution
- Passive and active continental margin evolution

Lecture notes

Detailed scriptum in digital form and additional learning modules (www.lead.ethz.ch) available on the intranet.

Literature


Data: 06.11.2018 12:57
Autumn Semester 2016
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### 651-3523-00L Hydrogeology and Quaternary Geology

**W+ 3 credits**

**M. Kleipkova, P. Haldimann, S. Ivy Ochs**

**Abstract**
This course provides the basics of quaternary geology and an overview of the aspects of the hydrogeology of quaternary sediments and karst within Switzerland.

**Objective**
- Become familiar with the processes that formed the landscapes during the last 2 Mio. years.
- Understand the types of landscape and the forming quaternary sediments.
- Get insight into the role of the quaternary aquifers and apply fundamental hydrogeological techniques.
- Learn about the risk exposure of aquifers and ways to protect.
- Familiarize with the concepts for characterization of fractured and karst aquifers.

**Content**
- Erforschungsgeschichte und Gliederung des Quartärs. Klimaentwicklung.
- Prozesse während Kaltzeiten (Eisvorschts, glaziale Erosion) und während Warmzeiten (Sedimentation, fluviatile Erosion) (mit Übungen).
- Quartäre Geomorphologie, quartäre Ablagerungen (mit Übungen).
- Entwicklungsgeschichte der Täler in den Alpen und im Alpenvorland (mit Übungen).
- Altersbestimmungen, Quartärstratigraphische Methoden. Stratigraphie der Tällullungen.
- Wiederholung Hydrogeologischer Grundlagen.
- Grundwasservorkommen der Schweiz (mit Übungen).
- Hydrogeologie quartärer Ablagerungen (namentlich fluvioglaziale Schotter).
- Nutzung und Bewirtschaftung der Grundwasservorkommen in quartären Ablagerungen (mit Übungen).
- Grundwasserzüchtung im Hauptsiedlungsraum der Schweiz.
- Gefährdung und Schutz der Grundwasservorkommen in quartären Lockergesteinen (mit Übungen).
- Einführung in die Hydrogeologie von Karst- und Karstgrundwasserleitern (mit Übung).

**Lecture notes**
Während der Vorlesung werden die wichtigsten Daten und Fakten auf Blättern abgegeben und im Internet zum Download bereitgestellt.

**Literature**
- Scandinavian University Press, Oslo.
- Zahlreiche Publikationen des BAFU zur Hydrologie und Hydrogeologie der Schweiz.

**Prerequisites / notice**
Voraussetzung erfolgreicher Abschluss von 701-0401-00 Hydrophäre.

### 651-3525-00L Introduction to Engineering Geology

**W+ 3 credits**

**S. Löw**

**Abstract**
This introductory course starts from a descriptions of the behavior and phenomena of soils and rocks under near surface loading conditions and their key geotechnical properties. Lab and field methods for characterization of soils, rocks and rock masses are introduced. Finally practical aspects of ground engineering, including tunneling and landslide hazards are presented.

**Objective**
Understanding the basic geotechnical and geomechanical properties and processes of rocks and soils. Understanding the interaction of rock and soil masses with technical systems. Understanding the fundamentals of geological hazards.

**Content**

**Lecture notes**
Written course documentation available under "Kursunterlagen".

**Literature**

### 651-3527-00L Earth Science Mapping Exercises II

**W+ 2 credits**

**J.P. Burg**

**Abstract**
Reading and interpretation of geological and climatological maps.

**Objective**
Reading and interpretation of geological and climatological maps.

**Content**

**Lecture notes**
Exercises and instructions are handed out. Requirement: Earth science mapping exercises I

**Prerequisites / notice**

### 651-3541-00L Exploration and Environmental Geophysics

**W+ 4 credits**

**F. Broginni, J. Doetsch**

**Abstract**
Overview and understanding of the most important geophysical methods: Potential field methods (Gravimetrics and Magnetics), Electrical and electromagnetic methods, Refraction and reflection seismics, Georadar. Discussion of survey design, sources and receivers and data processing.

**Objective**
Overview and understanding of the most important geophysical methods. Proposed solutions to assess and observe problems relevant to exploration and environmental geophysics in soil, ice and lithosphere at different scales. Getting familiar with measuring- and interpretation procedures. Potting out the possibilities and limitations of geophysical methods.

**Content**

**Lecture notes**
Available through eDoz/LIAS.

Additional material will be provided by the lecturers.
Overview and understanding of the most important geophysical methods. Proposed solutions to assess and observe problems relevant to
students are able to
Advanced analysis of geological maps and construction of geological sections. Special points: normal faults of the Rheintal graben, Bull
Scandinavian University Press, Oslo.
2.Zahlreiche Publikationen des BAFU zur Hydrologie und Hydrogeologie der Schweiz.

Prerequisites / notice
Voraussetzung erfolgreicher Abschluss von 701-0401-00 Hydrospäre

Primarily core courses of the BSc Earth Sciences majors should be chosen.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>651-3561-00L</td>
<td>Cryosphere</td>
<td>W</td>
<td>3 credits</td>
<td>2P M. Funk, M. Huss, K. Steffen</td>
</tr>
<tr>
<td>651-3541-00L</td>
<td>Exploration and Environmental Geophysics</td>
<td>W+</td>
<td>4 credits</td>
<td>3V F. Brogini, J. Doetsch</td>
</tr>
</tbody>
</table>

Cryosphere

This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere components both formally and using examples.

Objective
Students are able to
- qualitatively describe the main components of the cryosphere and their role in the climate system
- formally describe the relevant physical processes which determine the state of cryosphere components

Content
Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system. Each part is used to emphasize on one specific physical aspect: material qualities of ice, mass balance and dynamics of glaciers and energy balance of sea ice.

Lecture notes
Handouts will be distributed during the teaching semester

Earth Science Mapping Exercises II

Reading and interpretation of geological and climatological maps.

Objective
Reading and interpretation of geological and climatological maps.

Content

Lecture notes
Exercises and instructions are handed out.

Introduction to Engineering Geology

This introductory course starts from a descriptions of the behavior and phenomena of soils and rocks under near surface loading conditions and their key geotechnical properties. Lab and field methods for the characterization of soils, rocks and rock masses are introduced. Finally practical aspects of ground engineering, including tunneling and landslide hazards are presented.

Objective
Understanding the basic geotechnical and geomechanical properties and processes of rocks and soils. Understanding the interaction of rock and soil masses with technical systems. Understanding the fundamentals of geotechnical hazards.

Content

Lecture notes
Written course documentation available under "Kursunterlagen".

Literature


Major in Geophysics

Advisor of the major geophysics is Prof. Taras Gerya.

Major in Geophysics: Core Courses

From the offered core courses in autumn and spring semester, 27 credits have to be acquired.

Number      | Title                           | Type | ECTS | Hours | Lecturers
-------------|---------------------------------|------|------|-------|-----------
651-3541-00L | Exploration and Environmental Geophysics | W+  | 4 credits | 3V F. Brogini, J. Doetsch |

Exploration and Environmental Geophysics

Overview and understanding of the most important geophysical methods: Potential field methods (Gravimetrics and Magnetics), Electrical and electromagnetic methods, Refraction and reflection seismics, Georadar. Discussion of survey design, sources and receivers and data processing.

Objective
Overview and understanding of the most important geophysical methods. Proposed solutions to assess and observe problems relevant to exploration and environmental geophysics in soil, ice and lithosphere at different scales. Getting familiar with measuring- and interpretation procedures. Pointing out the possibilities and limitations of geophysical methods.

Content

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 559 of 1571
651-3543-00L  Seismology  W+  3 credits  2G  D. Giordani, D. Fäh

Abstract
General knowledge of seismology.

651-3527-00L  Earth Science Mapping Exercises II  W+  2 credits  2P  J.P. Burg

Abstract
Reading and interpretation of geological and climatological maps.

Objective
Advanced analysis of geological maps and construction of geological sections. Special points: normal faults of the Rheintal graben, Bull Lake West (USA), Val de Ruz, Helvetic nappes of the Säntis area. Reconstruction of the geological history of the map areas. References to the Geology of Switzerland.

Content
Introduction to generation of climatological maps. Analysis of synoptic scale patterns of air pressure and temperature advection on the surface and one upper air level. (Hydrostatic) Conclusions about vertical stratification of the atmosphere. Elementary prognostic interpretation. Inclusion of special actually weather phenomenon.

Lecture notes
Exercises and instructions are handed out.

Prerequisites / notice
Requirement: Earth science mapping exercises I

651-3525-00L  Introduction to Engineering Geology  W+  3 credits  3G  J.P. Burg

Abstract
This introductory course starts from a descriptions of the behavior and phenomena of soils and rocks under near surface loading conditions and their key geotechnical properties. Lab and field methods for the characterization of soils, rocks and rock masses are introduced. Finally practical aspects of ground engineering, including tunneling and landslides hazards are presented.

Objective
Understanding the basic geotechnical and geomechanical properties of rocks and soils. Understanding the interaction of rock and soil masses with technical systems. Understanding the fundamentals of geological hazards.

Content

Lecture notes
Written course documentation available under "Kursunterlagen".

Literature


651-3523-00L  Hydrogeology and Quaternary Geology  W+  3 credits  2G  M. Kleipkova, S. Löw

Abstract
This course provides the basics of quaternary geology and an overview of the aspects of the hydrogeology of quaternary sediments and karst within Switzerland.

Objective
- Become familiar with the processes that formed the landscapes during the last 2 Mio. years.
- Understand the types of landscape and the forming quaternary sediments.
- Get insight into the role of the quaternary aquifers and apply fundamental hydrogeological techniques.
- Learn about the risk exposure of aquifers and ways to protect.
- Familiarize with the concepts for characterization of fractured and karst aquifers

Content
Erforschungsgeschichte und Gliederung des Quartärs, Klimaentwicklung.
Prozesse während Kaltzeiten (Eisvorstösse, glaziale Erosion) und während Warmzeiten (Sedimentation, fluviatile Erosion) (mit Übungen).
Quartäre Geomorphologie, quartäre Ablagerungen (mit Übungen).
Entwicklungsgeschichte der Täler in den Alpen und im Alpenvorland (mit Übungen).
Altersbestimmungen, Quartär stratigraphische Methoden. stratigraphie der Talfüllungen.
Wiederholung Hydrogeologischer Grundlagen.
Grundwasservorkommen der Schweiz (mit Übungen).
Hydrogeologie quartärer Ablagerungen (namentlich fluvioglaziale Schotter).
Nutzung und Bewirtschaftung der Grundwasservorkommen in quartären Ablagerungen (mit Übungen).
Grundwassernutzung im Hauptsiedlungsraum der Schweiz.
Gefährdung und Schutz der Grundwasservorkommen in quartären Lockersteinen (mit Übungen).
Einführung in die Hydrogeologie von Kult- und Karstgrundwasserleitern (mit Übung).

Lecture notes
Während der Vorlesung werden die wichtigsten Daten und Fakten auf Blättern abgegeben und im Internet zum Download bereitgestellt.

Literature
Zahlreiche Publikationen des BAFU zur Hydrologie und Hydrogeologie der Schweiz

Prerequisites / notice
Voraussetzung erfolgreicher Abschluss von 701-0401-00 Hydrosphäre

651-3521-00L  Tectonics  W+  3 credits  2V  J.P. Burg, E. Kissling

Abstract
Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.
Objective

Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales.
Assessment of mechanisms responsible for plate movements (the Earth as a heat transfer machine, dynamics of earth mantle, plate driving forces) and subsequent large-scale structures (oceanic basins and cycle of the oceanic lithosphere, convergence and mountain systems and continental growth, etc) through theoretical and experimental information.
Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

Content

Plate tectonic frame work: earth cooling and mantle-plate interaction, three kinds of plate boundaries and their roles and characteristics, cycle of oceanic lithosphere, longlifey and growth of continents, supercontinents.
Rheology of layered lithosphere and upper mantle.
Oduction systems
Collisions systems
Extensional systems
Basin evolution
Passive and active continental margin evolution

Lecture notes
Detailed scriptum in digital form and additional learning moduls (www.lead.ethz.ch) available on the intranet.

Literature

651-3505-00L

Mineral Resources
W+ 3 credits 2V C. A. Heinrich, R. Kündig, W. Leu, F. Schenker

Abstract
Overview of the geological formation processes and the global distribution of mineral resources (metals, energy resources, bulk materials and industrial minerals), their economic importance, as well as the political and environmental aspects of responsible resource extraction and site rehabilitation.

Objective

Content
- Vorstellung der Dozierenden mit Fallstudien aus der persönlichen Berufspraxis (CH, RK, WL, FS)
- Ressourcen der Welt und Bedeutung für die Schweiz (RK)
- Metallische Erzlagerstätten - Einführung (CH)
- Metallische Erzlagerstätten - Magmatische Prozesse Test 1 (CH)
- Ozeanische Hydrothermalsysteme, Oberflächenenergie und Atmosphärenentwicklung (CH)
- Metallische Erzlagerstätten - Magmatisch-hydrothermale Systeme Test 2 (CH)
- Energierohstoffe - Einführung; Bildungsprozesse Petroleum und Erdgas (WL)
- Energierohstoffe - Öl und Gas (WL)
- Energierohstoffe - Kohle und CO2-Entsorgung Test 3 (WL/RK)
- Nichtmetallische Rohstoffe - Baustoffe (RK)
- Nichtmetallische Rohstoffe - Erden (RK/FS)
- Nichtmetallische Rohstoffe - Industriemetalen Test 4 (FS)

Lecture notes
Kursnotizen werden in den Stunden verteilt

Literature

Prerequisites / notice

651-3503-00L

Metamorphism
W+ 3 credits 2G M. W. Schmidt

Abstract
Understanding of the principles governing (chemical) reactions in metamorphic processes and resulting (physical) properties of metamorphic rocks s.l.. Recognition of metamorphic minerals and rocks (e.g. Gesteinsbestimmung)

651-3501-00L

Isotope Geochemistry and Isotope Geology
W+ 3 credits 2G S. Bernasconi, D. Vance

Abstract
The course focuses on the most important systems of radioactive and stable isotopes used in geochemistry and geology. Applications of isotope geochemistry for solving fundamental geological problems are discussed on the basis of case studies.

Objective
Development of a basic knowledge and understanding of the applications of the most important systems of stable and radiogenic isotopes.

Content
The following methods will be discussed in detail: the radioactive-radiogenic systems Rb-Sr, Sm-Nd, U-Th-Pb and K-Ar, as well as the stable isotope systems of oxygen, carbon, nitrogen, sulfur and hydrogen.

We will discuss how these methods are used in the following research fields: geochemistry of the earth, age dating, paleotemperature reconstructions, evolution of the crust and mantle reservoirs, sediment diagenesis, fluid rock interactions, hydrothermal activity, paleoceanoigraphy, biogeochemical cycles.

Lecture notes
Available

- Dickin A. P., Radiogenic Isotope Geology, (2005), Cambridge University Press

Prerequisites / notice
Geochemie I: (Bachelor course)
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-3597-00L</td>
<td>Bachelor's Seminar I</td>
<td>W+</td>
<td>2 credits</td>
<td>2S</td>
<td>W. Schatz, J. D. Rickli</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>In this seminar, students learn to search effectively for scientific knowledge and how to present scientific results orally and in written form to different audiences.</td>
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<td>Objective</td>
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<td></td>
<td>Students are also held scientific presentations.</td>
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<td></td>
<td>Students can plan and present a scientific poster.</td>
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<td>Students can search scientific publications in an effective and efficient manner.</td>
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<td>Content</td>
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<td></td>
<td>Auftreten vor Publikum</td>
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<td></td>
<td>(Gestik, Haltung, Sprechen und Sprache, Hemmungen abbauen)</td>
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<td>Medieneinsatz</td>
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<td>(Powerpoint Standard für wissenschaftliche Präsentationen, Stärken und Gefahren von Präsentationen mit Powerpoint; Einsatz von Text, Graphiken, Ton, Video, Animationen etc.)</td>
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<td></td>
<td>Beantwortung von Fragen: das Nach-dem-Vortrag, Umgang mit Fragen, Verhalten in kritischen Situationen</td>
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<tr>
<td></td>
<td>Tipps zum Zeitmanagement</td>
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<td></td>
<td>Kriterien für Bewertung von Vorträgen anwenden können und konstruktives Feedback geben können</td>
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<td>(Was ist gut? Warum? Was ist nicht so gut? Warum nicht und wie wäre es besser?)</td>
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<td></td>
<td>Strukturieren, Reduzieren, Fokussieren, Präzisieren, Gliederung und Aufbau eines Posters</td>
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<td>Technische Anforderungen (Software, Drucken ...)</td>
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<td>Posterpräsentation</td>
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<td>Effizientes Suchen nach wissenschaftlichen Publikationen (Bibliotheken, Datenbanken, search tools ...)</td>
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<td></td>
<td>Analyse von wissenschaftlichen Artikeln (Aufbau, Struktur, Beurteilung der Qualität ...)</td>
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</table>

**Major in Geophysics: Electives**

*From all elective courses offered in the autumn and spring semester, 12 credits have to be acquired.*

**Major in Climate and Water: Electives**

This practical course is compulsory for the BSc-specialization "geophysics".

**Major in Climate and Water: Core Courses**

*14 credits have to be acquired of the offered core courses from autumn and spring semester.*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-3597-00L</td>
<td>Cryosphere</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Funk, M. Huss, K. Steffen</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>This course introduces the different parts of the cryosphere: snow, glaciers, sea ice, permafrost - and their role in the climate system. A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere components both formally and using examples.</td>
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<td>Objective</td>
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<td>Students are able</td>
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<td>- to qualitatively describe the main components of the cryosphere and their role in the climate system</td>
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<td>- to formally describe the relevant physical processes which determine the state of cryosphere components</td>
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<tr>
<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system. Each part is use to emphasized on one specific physical aspect: material qualities of ice, mass balance and dynamics of glaciers and energy balance of sea ice.</td>
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<td></td>
<td>Lecture notes</td>
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<td>handouts will be distributed during the teaching semester</td>
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</table>

**Major in Geophysics: Compulsory Laboratory Courses**

**Advisor of the BSc-major "Climate and Water" is Dr. Erich Fischer, Institute for climate and atmosphere (IAC).**

**Major in Climate and Water: Core Courses**
### 701-0475-00L
**Atmospheric Physics**  
*W* 3 credits  2G  U. Lohmann, A. A. Mensah

**Abstract**  
This course covers the basics of atmospheric physics, which consist of: cloud and precipitation formation, thermodynamics, aerosol physics, radiation as well as the impact of aerosols and clouds on climate and artificial weather modification.

**Objective**  
- Students are able to explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.
- To evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.

**Content**  
Mist processes/thermodynamics; aerosol physics; cloud formation; precipitation processes, storms; importance of aerosols and clouds for climate and weather modification, clouds and precipitation.

**Lecture notes**  
Powerpoint slides and script will be made available.

**Literature**  

**Prerequisites / notice**  
50% of the time we use the concept of "flipped classroom" (en.wikipedia.org/wiki/Flipped_classroom), which we introduce at the beginning.

We offer a lab tour, in which we demonstrate with some instruments how some of the processes, that are discussed in the lectures, are measured.

There is a additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but voluntary.

### 701-0461-00L
**Numerical Methods in Environmental Sciences**  
*W* 3 credits  2G  C. Schär, O. Fuhrer

**Abstract**  
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Objective**  
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Content**  
Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Three obligatory exercises, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary: a Matlab introduction is given). Example programs and graphics tools are supplied.

**Lecture notes**  
Is provided (CHF 10. per copy).

**Literature**  
List of literature is provided.

### 701-0473-00L
**Weather Systems**  
*W* 3 credits  2G  M. A. Sprenger, C. Grams

**Abstract**  
This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.

**Objective**  
The students are able to explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics.
- To discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena.
- To explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features.
- To explain how mountains influence the atmospheric flow on different scales.

**Content**  
Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situtations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

**Lecture notes**  
Lecture notes and slides

**Literature**  
Atmospheric Science, An Introductory Survey  
John M. Wallace and Peter V. Hobbs, Academic Press

### >>> Major in Climate and Water: Electives

In addition to the mandatory seminar for Bachelor Students: Atmosphere and Climate (course nr. 701-0459-00 in autumn semester) another 22 credits must be acquired from the offered elective courses during the 5th and 6th semester. The choice of other courses has to be granted by the advisor (Dr. Erich Fischer).

**Number**  
**Title**  
**Type**  
**ECTS**  
**Hours**  
**Lecturers**

<table>
<thead>
<tr>
<th>701-0459-00L</th>
<th>Seminar for Bachelor Students: Atmosphere and Climate</th>
<th>O</th>
<th>2 credits</th>
<th>2S</th>
<th>R. Knutti, H. Joos, O. Stebler</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>In this seminar all students in the realm of atmospheric and climate science convene to train presentation techniques (talks, posters) by means of classic and modern scientific articles.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>In this seminar all students in the realm of atmospheric and climate science convene to train presentation techniques (talks, posters) by means of classic and modern scientific articles.</td>
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</tbody>
</table>
| **Content** | 1st week: course organisation and presentation of the institute  
2nd and 3rd week: introduction to oral presentation technique  
week 4 to 10: students talks  
11th week: introduction to poster presentation  
12th and 13th week: poster design  
14th week: concluding poster presentation |
| **Lecture notes** | Documents are offered via the course's web page. |
| **Literature** | Documents are offered via the course's web page. |
| **Prerequisites / notice** | This course can only be offered to a limited number of students, however, in any case for everybody having to attend it compulsory. We beg you to sign in to this course early. |

<table>
<thead>
<tr>
<th>102-0635-01L</th>
<th>Air Pollution Control</th>
<th>W</th>
<th>6 credits</th>
<th>4G</th>
<th>B. Buchmann, P. Hofer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>The lecture provides in the first part an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and their im-pact on air quality. The second part covers different strategies and techniques for emission reduction. The basic knowledge is deepened by the discussion of specific air pollution problems of today's society.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost. The students know the different techniques of air pollution control and their scientific basements. They are able to incorporate goals concerning the air quality into their engineering work.</td>
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</table>
### Content

#### Part 1: Emission, Immission, Transmission
- Fluxes of pollutants and their environmental impact
- Physical and chemical processes leading to emission of pollutants
- Mass and energy of processes
- Emission measurement techniques and concepts
- Quantification of emissions from individual and aggregated sources
- Extent and development of the emissions (Switzerland and global)
- Propagation and transport of pollutants (transmission)
- Meteorological parameters influencing air pollution dispersion
- Deterministic and stochastic models, describing the air pollution dispersion
- Dispersion models (Gaussian model, box model, receptor model)
- Measurement concepts for ambient air (immission level)
- Extent and development of ambient air mixing ratios
- Goal and instrument of air pollution control

#### Part 2: Air Pollution Control Technologies
- The reduction of the formation of pollutants is done by modifying the processes (pro-cess-integrated measures) and by different engineering operations for the cleaning of waste gas (downstream pollution control). It will be demonstrated, that the variety of these procedures can be traced back on the application of a few basic principles of physical chemistry.
- Procedures for the removal of particles (inertial separator, filtration, electrostatic pre-cipitators, scrubbers) with their different mechanisms (field forces, impaction and diffusion processes) and the modelling of these mechanisms.
- Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biological conversions).
- Discussion of the technical possibilities to solve the actual air pollution problems.

#### Literature
- Brigitte Buchmann, Air pollution control, Part I
- Using R for Data Analysis and Graphics (Part I)
- A. Drewek
- Faraway (2005): Linear Models with R
- Environmental Soil Physics/Vadose Zone Hydrology
- Peter Hofer, Air pollution control, Part II
- Lecture slides and exercises
- A. J. Papritz

#### Prerequisites / notice

- College lectures on basic physics, chemistry and mathematics

### 401-0649-00L Applied Statistical Regression

<table>
<thead>
<tr>
<th>W</th>
<th>5 credits</th>
<th>2V+1U</th>
<th>M. Dettling</th>
</tr>
</thead>
</table>

**Abstract**
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

**Objective**
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

**Content**
The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

**Lecture notes**
A script will be available.

**Literature**
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery & Peck (2001): Introduction to Linear Regression Analysis

**Prerequisites / notice**
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

### 401-6215-00L Using R for Data Analysis and Graphics (Part I)

<table>
<thead>
<tr>
<th>W</th>
<th>1 credit</th>
<th>G</th>
<th>A. Drewek, A. J. Papritz</th>
</tr>
</thead>
</table>

**Abstract**
The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

**Objective**
The students will be able to use the software R for simple data analysis.

**Content**
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

**Lecture notes**
An Introduction to R. http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf

**Prerequisites / notice**
The course resources will be provided via the Moodle web learning platform. Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145

Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

### 701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>2G+2U</th>
<th>D. Or</th>
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</table>

This course focuses on the practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

**Lecture notes**
An Introduction to R. http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf

**Prerequisites / notice**
The course resources will be provided via the Moodle web learning platform. Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145

Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.
### 701-0479-00L

**Environmental Fluid Dynamics**

| W | 3 credits | 2G | H. Wernli, M. Croci-Maspoli |

**Abstract**

This course covers the basic physical concepts and mathematical equations used to describe environmental fluid systems on the rotating Earth. Fundamental concepts (e.g. vorticity dynamics and waves) are formally introduced, applied quantitatively and illustrated using examples. Exercises help to deepen knowledge of the material.

**Objective**

Students are able to:

- to understand the basic, concepts and methods of environmental fluid dynamics;
- to understand and discuss the components of the basic physical equations in fluid dynamics;
- to apply basic mathematical equations to simple problems of environmental fluid dynamics

**Content**

- Basic physical terminology and mathematical laws:
- Continuum hypothesis, forces, constitutive laws, state equations and basic principles of thermodynamics, kinematics, laws of mass and momentum on rotating earth.
- Concepts and illustrative flow systems: vorticity dynamics, boundary layers, instability, turbulence - with respect to environmental fluid systems.
- Scale analysis: dimensionless variables and dynamical similarity, simplification of the fluid system, e.g. shallow water assumption, geostrophic flow.
- Waves in environmental fluid systems.

**Lecture notes**

In English language

**Literature**

Will be presented in class.
See also: web-site.

### 102-0455-01L

**Groundwater I**

| W | 3 credits | 2G | M. Willmann |

**Abstract**

The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focused on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.
Objective

a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.

b) Students are able to formulate simple practical flow and transport problems.

c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.

d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.

Content

Properties of porous media.
Exercises: Groundwater use, porosity, grain size analysis.

Flow properties, Darcy's law, filter.
Flow equations, stream function.
Exercises: Darcy's law.

Analytical solutions, confined aquifers, steady-state flow.
Exercises: Head isolines.

Use of superposition principles, transient flow, free surface flow.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems I.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems II.
Exercises: Finite difference formulations to flow problems.

Transport processes.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems I.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems II.
Exercises: Analytical solutions to transport problems.

Path lines, groundwater protection.
Exercises: Analytical solutions to transport problems.

Groundwater remediation, groundwater management.
Exercises: Groundwater remediation.

Lecture notes

Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index
Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index
Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index

Literature

W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995
Krussemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970
G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

651-3561-00L Cryosphere 3 credits 2V M. Funk, M. Huss, K. Steffen

Abstract
This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere components both formally and using examples.

Objective
Students are able
- to qualitatively describe the main components of the cryosphere and their role in the climate system
- to formally describe the relevant physical processes which determine the state of cryosphere components

Content
Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system.
Each part is use to emphasized on one specific physical aspect: material qualities of ice, mass balance and dynamics of glaciers and energy balance of sea ice.

Lecture notes
handouts will be distributed during the teaching semester

Field Trips, Laboratory and Block Courses

The Practical Training in Atmosphere and Climate takes place in Spring Semester.

Electives

Courses can be chosen from the complete offerings of the ETH Zurich and University of Zurich.

Number Title Type ECTS Hours Lecturers
701-0565-00L Fundamentals of Natural Hazards Management W 3 credits 3G H. R. Heinimann, B. Krummenacher, S. Löw

Abstract
Risks to life and human assets result when settlement areas and infrastructure overlap regions where natural hazard processes occur. This course utilizes case studies to teach how a future natural hazards-specialist should analyze, assess and manage risks.
Objective

Concepts will be explained step-by-step through a set of case studies, and applied in lab by the students. The following principal steps are used when coping with natural hazard-risks. At each step, students will learn and apply the following skills:
- Risk analysis - What can happen?
  - Characterize the processes and environmental measures that lead to a natural hazard and integrate modeling results of these processes.
  - Identify threats to human life and assets exposed to natural hazards and estimate possible drawbacks or damages.
- Risk assessment - What are the acceptable levels of risk?
  - Apply principles to determine acceptable risks to human life and assets in order to identify locations which should receive added protection.
  - Explain causes for conflicts between risk perception and risk analysis.
- Risk management - What steps should be taken to manage risks?
  - Explain how various hazard mitigation approaches reduce risk.
  - Describe hazard scenarios as a base for adequate dimensioning of control measures.
  - Identify the best alternative from a set of thinkable measures based on an evaluation scheme.
- Explain the principles of risk-governance.

Content

Die Vorlesung besteht aus folgenden Blöcken:
1) Einführung ins Vorgehenskonzept (1W)
   - Systemabgrenzung
   - Gefahrenbeurteilung
   - Expositions- und Folgenanalyse
2) Risikoanalyse (6W + Exkursion) mit:
   - Expositions- und Folgenanalyse
3) Risikobewertung (2W)
4) Risikomanagement (2W + Exkursion)
5) Abschlussbesprechung (1W)

Choice of courses from the complete offerings of ETH and UZH.

► Social Sciences

Recommended Science in Perspective (Type B) for D-ERDW.

see Science in Perspective: Type A: Enhancement of Reflection Capability

see Science in Perspective: Language Courses ETH/UZH

► Bachelor’s Seminar

The Bachelor Seminar (651-3698-00L) takes place in spring semester.

► Bachelor’s Thesis

The Bachelor Thesis and Bachelor-Seminar are offered once per year in the 6th semester, in the spring.

► Complementary Courses

The Complementary Courses take place in Spring Semester.

Earth Sciences Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>O</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>Letter</th>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
# Earth Sciences Master

- **Major in Geology**

- **Compulsory Module in Analytical Methods in Earth Sciences**
  
  Students have to complete 6 credits in part A, and 6 credits in part B.

### Part A: Microscopy Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4045-00L</td>
<td>Microscopy of Metamorphic Rocks</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>P. Nievergelt</td>
</tr>
<tr>
<td></td>
<td>Repetition of methods using optic properties of crystals and the polarising microscope.</td>
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<tr>
<td></td>
<td>Identification of minerals and metamorphic parageneses.</td>
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<tr>
<td></td>
<td>Description and interpretation of microstructures.</td>
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<td></td>
<td>Age relationship of crystallisation and deformation.</td>
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<tr>
<td></td>
<td>Estimation of metamorphic grade.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>- Advanced knowledge in optical mineralogy</td>
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<tr>
<td></td>
<td>- Application of methods to determine minerals in thin sections</td>
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<tr>
<td></td>
<td>- Identification and characterisation of metamorphic minerals</td>
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<tr>
<td></td>
<td>- Description of rocks. Derive correct petrographic rock name, based on modal abundance and microstructure/texture</td>
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<tr>
<td></td>
<td>- Interpretation of rock fabric/microstructure, parageneses and mineral reactions</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>- Repetition of principal optical properties and of microscopic methods to identify minerals. Emphasis on interpretation of interference figures.</td>
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<tr>
<td></td>
<td>- Study typical metamorphic rocks in thin sections</td>
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<tr>
<td></td>
<td>- Description and interpretation of parageneses and texture/microstructures. Study the age relationship of crystallisation and deformation.</td>
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<tr>
<td></td>
<td>- Estimation of metamorphic grade</td>
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<tr>
<td></td>
<td>- Quantitative determination. To determine volume percentage of rock components</td>
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<tr>
<td></td>
<td>- Scientific documentation: Descriptions, drawings, photomicrography using different kinds of illumination and using plane- or circular-polarised light.</td>
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</tbody>
</table>

- **Lecture notes**
  
  Handouts with additional information on theory and for exercises, in English.

- **Literature**
  
  - Nesse, W.D.: Introduction to optical mineralogy. 3. Ed. (2004). Figures from this book will be used in lectures. Besides the theory, this book describes all optical properties of important minerals. Petrographers working on varying types of silicate rocks should have a look at this book.
  
  

- **Prerequisites / notice**
  
  Participants should have basic knowledge in crystallography, mineralogy and petrology, and have taken practical courses in microscopy of thin sections, as well as lectures in metamorphic petrology and structural geology!

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4047-00L</td>
<td>Microscopy of Magmatic Rocks</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>P. Ulmer</td>
</tr>
<tr>
<td></td>
<td>This course provides basic knowledge in microscopy of igneous rocks. Apart from the identification of common igneous minerals in thin sections, mineral assemblages, textures and structures will be investigated and the results of microscopy will be combined with igneous phase equilibria to understand generation, differentiation and emplacement of igneous rocks.</td>
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</tbody>
</table>

- **Abstract**
  
  The principal goal of this course is to acquire expertise in:
  
  (1) optical determination of minerals in igneous rocks using the polarizing microscope
  
  (2) Identification of igneous rocks basing on modal mineralogy, structure and texture;
  
  (3) Interpretation of textures and structures and associated igneous processes;
  
  (4) Application of igneous phase diagrams to natural rocks.

- **Content**
  
  This practical course bases on the course 'Microscopy of metamorphic rocks' (P. Nievergelt), that is taught immediately before this course, where basic knowledge in optical mineralogy and the use of the polarizing microscope is acquired.

  In this course, the most important (common) igneous minerals and rocks are studied in thin sections under the polarizing microscope. Mineral assemblages, textures, structures and crystalization sequences are determined and utilized to understand the generation, differentiation and emplacement of igneous rocks. In addition, we will apply igneous phase equilibria that have been introduced in other lectures (such as magmatism and volcanism at ETH/Uni Zurich or an equivalent igneous petrology course) to natural rock samples in order to constrain qualitatively parental magma compositions and crystallization conditions.

  The range of investigated rocks encompasses mantle rocks, tholeiitic, calc-alkaline and alkaline plutonic and volcanic rocks that contain the most common igneous minerals.

- **Lecture notes**
  
  Basis of the optical determinations of (igneous) minerals using the polarizing microscope are the tables of Tröger (‘Optische Bestimmung der gesteinsbildenden Minerale’, Optical determination of rock-forming minerals, 1982) that are available in sufficient volumes in the class room.

  Some loose sheets will be distributed during the lecture providing additional information and templates for thin section descriptions.

  Additionally, I recommend the lecture notes of H.-G. Stosch (University of Karlsruhe, in German) that can be provided in printed form upon request.

- **Literature**
  
  There are several good textbooks on the subject of ‘mineralogy in thin sections’ that I can suggest upon request.

- **Prerequisites / notice**
  
  This course does not include an introduction in optical mineralogy and the use of a polarizing microscope and, therefore, bases on the course ‘Microscopy of metamorphic rocks’ taught by P. Nievergelt immediately before this course where these basic principles are provided. Alternatively, e.g. for external students, an equivalent course is required to follow this practical course.

Other microscopy courses taught at ETH Zurich at the D-ERDW are:

- Microscopy of metamorphic rocks (P. Nievergelt, required for this course)
- Microscopy of sedimentary rocks (W. Winkler & Blaesi)
- Reflectd light microscopy and ore deposits practical (T. Driesner)
- Microstructures (deformation structures, B. Cordonnier)
The course offers a series of basic methods useful for the analysis of sediments. It is also offered to apply these methods on material.

**Contents**

- **Sedimentary Petrography and Microscopy**
  - Microscopy of carbonate (1st half of semester) and siliciclastic rocks (2nd half) rocks as well as siliceous, phosphatic and evaporitic sediments.
- **Geographic Information Systems**
  - Introduction to the architecture and data processing capabilities of geographic information systems (GIS).
  - Practical application of spatial data modeling and geoprocessing functions to a selected project from the earth sciences.

**Prerequisites / notice**

- To be handed out in class
- Credits and mark based on independent description of selected sample(s) towards the end of the course

### Part B: Methods

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4055-00L</td>
<td>Analytical Methods in Petrology and Geology</td>
<td>W+</td>
<td>3</td>
<td>2</td>
<td>E. Reusser, S. Bernasconi, L. Zehnder</td>
</tr>
<tr>
<td>651-4117-00L</td>
<td>Sediment Analysis</td>
<td>W+</td>
<td>3</td>
<td>2</td>
<td>M. G. Fellin, A. Gilli, V. Picotti</td>
</tr>
<tr>
<td>651-4031-00L</td>
<td>Geographic Information Systems</td>
<td>W+</td>
<td>3</td>
<td>4</td>
<td>A. Baltensweiler, M. Hägele-Golay</td>
</tr>
<tr>
<td>651-4063-00L</td>
<td>X-ray Powder Diffraction</td>
<td>W+</td>
<td>3</td>
<td>2</td>
<td>L. M. Plötzé</td>
</tr>
</tbody>
</table>

**Abstract**

- Introduction to reflected light microscopy. Use of the microscope. Identification of opaque minerals through the used of tables. Description of textures and paragenetic sequences.

- Given Participants should attend in parallel with Ore Deposits I (651-4037-00L).

**Objective**

- Recognition of the most important ore minerals in polished section, interpretation of mineral textures in geological context

- Introduction to reflected light microscopy as a petrographic technique. Leaning main diagnostic criteria. Study of small selection of important and characteristic minerals. Interpreting polished (thin) sections as exercise

**Lecture notes**

- The earlier attendance of other MSc microscopy courses (e.g. magmatic and metamorphic rocks) is not required if during the BSc a general course on microscopy of rocks was completed.

**Literature**


**Prerequisites / notice**

- It is desirable but not excluding that the students bring their own material (Master or PhD project) for some of the analytical methods.
Restricted Choice Modules Geology

A minimum of two restricted choice modules must be completed for the major Geology.

Palaeoclimatology: Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4057-00L</td>
<td>Climate History and Palaeoclimatology</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>S. Bernasconi, B. Ausin Gonzalez, A. Fernandez Bremer, A. Gilli</td>
</tr>
</tbody>
</table>

Abstract
The course "Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in palaeoclimatic research.

Objective
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics- through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary paleoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content
Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.

Geological time, stratigraphy, geological archives, climate archives, palaeoclimate proxies

Climate through geological time: "lessons from the past"

Cretaceous greenhouse climate
The Late Paleocene Thermal Maximum (PETM)
Cenozoic Cooling
Onset and Intensification of Southern Hemisphere Glaciation
Onset and Intensification of Northern Hemisphere Glaciation
Pliocene warmth
Glacial and Interglacials
Millennial-scale climate variability during glaciations
The last deglaciation(s)
The Younger Dryas

Holocene climate - climate and societies

Palaeoclimatology: Courses of Choice

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4043-00L</td>
<td>Sedimentology II: Biological and Chemical Processes in Lacustrine and Marine Systems</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>V. Picotti, A. Gilli</td>
</tr>
</tbody>
</table>

Abstract
The course will focus on biological and chemical aspects of sedimentation in marine environments. Marine sedimentation will be traced from coast to deep-sea. The use of stable isotopes palaeoceanography will be discussed. Neritic, hemipelagic and pelagic sediments will be used as proxies for environmental change during times of major perturbations of climate and oceanography.

Objective
-You will understand chemistry and biology of the marine carbonate system
-You will be able to relate carbonate mineralogy with facies and environmental conditions
-You will be familiar with cool-water and warm-water carbonates
-You will see carbonate and organic-carbon rich sediments as part of the global carbon cycle
-You will be able to recognize links between climate and marine carbonate systems (e.g. acidification of oceans and reef growth)
-You will be able to use geological archives as source of information on global change
-You will have an overview of marine sedimentation through time

Content
-carbonates:, chemistry, mineralogy, biology
-carbonate sedimentation from the shelf to the deep sea
-carbonate facies
-cool-water and warm-water carbonates
-organic-carbon and black shales
-C-cycle, carbonates, Corg : CO2 sources and sink
-carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr
-marine sediments through geological time
-carbonates and evaporites
-lacustrine carbonates
-economic aspects of limestone

Lecture notes
No script. Scientific articles will be distributed during the course

Literature
We will read and critically discuss scientific articles relevant for "biological and chemical processes in marine and lacustrine systems"
The grading of students is based on in-class exercises and end-semester examination.

### Sedimentology

#### Sedimentology: Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4041-00L</td>
<td>Sedimentology I: Physical Processes and Sedimentary Systems</td>
<td>W++</td>
<td>3 credits</td>
<td>2G</td>
<td>V. Picotti</td>
</tr>
<tr>
<td>Abstract</td>
<td>Sediments preserved a record of past landscapes. This course focuses on understanding the processes that modify sedimentary landscapes with time and how we can read changes in the sedimentary record.</td>
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<tr>
<td>Objective</td>
<td>The students learn basic concepts of modern sedimentology and stratigraphy in the context of sequence stratigraphy and sea level change. They discuss the advantages and pitfalls of the method and look beyond. In particular we pay attention to introducing the importance of considering entire sediment routing systems and understanding their functioning.</td>
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</tr>
<tr>
<td>Content</td>
<td>Details on the program will be handed out during the first lecture.</td>
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</tr>
<tr>
<td>Literature</td>
<td>The sedimentary record of sea-level change</td>
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<tr>
<td></td>
<td>Angela Coe, the Open University.</td>
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<tr>
<td></td>
<td>Cambridge University Press</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The grading of students is based on in-class exercises and end-semester examination.</td>
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</tbody>
</table>

| Number     | Sedimentology II: Biological and Chemical Processes in Lacustrine and Marine Systems | W++  | 3 credits | 2G    | V. Picotti, A. Gilli |
| Abstract   | The course will focus on biological and chemical aspects of sedimentation in marine environments. Marine sedimentation will be traced from coast to deep-sea. The use of stable isotopes palaeoceanography will be discussed. Nertic, hemipelagic and pelagic sediments will be used as proxies for environmental change during times of major perturbations of climate and oceanography. |
| Objective  | - You will understand chemistry and biology of the marine carbonate system  |
|            | - You will be able to relate carbonate mineralogy with facies and environmental conditions |
|            | - You will be familiar with cool-water and warm-water carbonates            |
|            | - You will see carbonate and organic-carbon rich sediments as part of the global carbon cycle |
|            | - You will be able to recognize links between climate and marine carbonate systems (e.g. acidification of oceans and reef growth) |
| Content    | - carbonates; chemistry, mineralogy, biology                              |
|            | - carbonate sedimentation from the shelf to the deep sea                   |
|            | - carbonate facies                                                         |
|            | - cool-water and warm-water carbonates                                     |
|            | - organic-carbon and black shales                                         |
|            | - C-cycle, carbonates, Corg : CO2 sources and sinks                       |
|            | - Carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr |
|            | - marine sediments thorough geological time                                |
|            | - carbonates and evaporites                                                |
|            | - lacustrine carbonates                                                    |
|            | - economic aspects of limestone                                           |
| Lecture notes | no script. scientific articles will be distributed during the course |
| Literature | We will read and critically discuss scientific articles relevant for "biological and chemical processes in marine and lacustrine systems" |
| Prerequisites / notice | The grading of students is based on in-class exercises and end-semester examination. |

#### Sedimentology: Courses of Choice

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4901-00L</td>
<td>Quaternary Dating Methods</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>I. Hajdas, S. Ivy Ochs</td>
</tr>
<tr>
<td>Abstract</td>
<td>Reconstruction of time scales is critical for all Quaternary studies in both Geology and Archeology. Various methods are applied depending on the time range of interest and the archive studied. In this lecture we focus on the six methods that are most frequently used for dating Quaternary sediments and landforms.</td>
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<tr>
<td>Objective</td>
<td>Students will be made familiar with the details of the six dating methods through lectures on basic principles, analysis of case studies, solving of problem sets for age calculation and visits to dating laboratories.</td>
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<tr>
<td>Content</td>
<td>At the end of the course students will:</td>
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<tr>
<td></td>
<td>1. understand the fundamental principles of the most frequently used dating methods for Quaternary studies.</td>
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<td></td>
<td>2. be able to calculate an age based on data of the six methods studied.</td>
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<td></td>
<td>3. choose which dating method (or combination of methods) is suitable for a certain field problem.</td>
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<td></td>
<td>4. critically read and evaluate the application of dating methods in scientific publications.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Visit to radiocarbon lab, cosmogenic nuclide lab, noble gas lab, accelerator (AMS) facility.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>X-ray Powder Diffraction</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>L. M. Plötz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for qualitative and quantitative mineral composition as well as crystallographic parameters.</td>
<td></td>
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</tbody>
</table>

Autumn Semester 2016
Objective

Upon successful completion of this course students are able to:
- describe the principle of X-ray diffraction analysis
- carry out a qualitative and quantitative mineralogical analysis independently,
- critically assess the data,
- communicate the results in a scientific report.

Content

Fundamental principles of X-ray diffraction
Setup and operation of X-ray diffractometers
Interpretation of powder diffraction data
Qualitative and quantitative phase analysis of crystalline powders (e.g. with Rietveld analysis)

Lecture notes

Selected handouts will be made available in the lecture

Literature


Prerequisites / notice

The course includes a high portion of practical exercises in sample preparation as well as measurement and evaluation of X-ray powder diffraction data.
Own sample will be analysed qualitatively and quantitatively. Knowledge in mineralogy of this system is essential.

The lecture course is limited to 12 participants.

Structural Geology

Objective

At the end of this course, the students should be able to
- Use Matlab for their future needs (e.g., for their MSc Thesis)
- Understand the fundamental concept of the finite-element method
- Apply the finite-element method to successfully work on a small project tailored to the student's interests.

In addition, innovative methods will be applied to mark the performance in the course, which includes self-evaluation and peer-evaluation among the students. Therefore, some soft-skills will be required and trained as well, such as
- honest self-evaluation and self-grading
- providing honest feedback to a colleague in a tone that is acceptable
- receiving feedback from a colleague without taking criticism personal
- learning the procedure of scientific peer-evaluation

Content

Introduction to Matlab
Continuum mechanics equations necessary to describe rock deformation
Rheological equations: elasticity + viscous materials
Introduction to the finite-element method (in 1D)
Numerical integration + isoparametric elements
Going to 2D finite elements
Finite-element method for 2D elasticity
Stress calculation + visualization
Finite-element method for 2D viscous materials
Heterogeneous media
Final project-based work tailored to the student's interest.

A substantial part of the lecture will take place in the computer-lab, where numerical finite element codes will be applied. The used software is Matlab. Students may bring their own laptop with a pre-installed copy of Matlab.

Lecture notes

The script is very diverse and ranges from PowerPoint-based pdf-files, to self-study tutorials. Also, the more theoretical and mathematical aspects will be explained on the black board without a proper script.

Literature

There is no mandatory literature. The following literature is recommanded:

Prerequisites / notice

The used software is Matlab. So, knowledge of Matlab is advantageous. Students may bring their own laptop with a pre-installed copy of Matlab.
651-4111-00L Rock Physics W 3 credits 2G A. S. Zappone, K. Kunze, C. Madonna

Abstract
The modern discipline of Rock Physics serves as a bridge between traditional Rock Mechanics and traditional Rock Physical Property measurement. Through understanding the physics of the process, we strive to better understand other related fields such as structural geology and geophysics.

Objective
The objective of this course is to introduce Rock Physics as a laboratory and interpretive tool.

Content
The course will consists of regular classes, with a small number of laboratory demonstrations made on an ad-hoc basis (depending on equipment and research objective schedules at the Rock Deformation Laboratory). The course will cover measurements of physical properties of rocks such as density, porosity, permeability and elastic wave velocity, and will introduce the concept of seismic seismic anisotropy etc. Later we will cover rock deformation in the brittle field, earthquake physics and triggering. Finally we will discuss scale effects as we move from small scale laboratory environment to the scale of the geophysical investigation.

Prerequisites / notice
Undergraduate courses in the following subjects are highly recommended in order to get the most out of this specialist course:
- Basic structural Geology
- Geophysics

651-3521-00L Tectonics W 3 credits 2V J.P. Burg E. Kissling

Abstract
Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

Objective
Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales.

Content
- Plate tectonic frame work: earth cooling and mantle-plate interaction, three kinds of plate boundaries and their roles and characteristics, cycle of oceanic lithosphere, longlifety and growth of continents, supercontinents.
- Rheology of layered lithosphere and upper mantle.
- Obduction systems
- Collisions systems
- Extensional systems
- Basin evolution
- Passive and active continental margin evolution

Lecture notes
Detailed scriptum in digital form and additional learning module (www.lead.ethz.ch) available on the intranet.

Literature

Biogeochemistry

Biogeochemistry: Compulsory Courses
The compulsory courses of the module take place in spring semester.

Biogeochemistry: Courses of Choice

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4058-00L</td>
<td>Basics of Palaeobotany (University of Zurich)</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Abstract
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BIO280

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Content
- Preservation of plants in the fossil record.
- First evidence for plants on Earth.
- The conquest of the continents by plants.
- Major adaptation and innovations leading to the present plant diversity.
- The evolution and morphology of the major plant groups.
- Plant associations through geological time and their palaeoecographic and stratigraphic relevance.
- Mass extinctions and the fossil plant record.
- Interaction between past vegetation and climate.
- The relevance of plant microfossils for reconstruction of palaeoclimate and palaeoecology.

651-4043-00L Sedimentology II: Biological and Chemical Processes W 3 credits 2G V. Picotti, A. Gilli

Prerequisite: Successful completion of the MSc-course "Sedimentology I" (651-4041-00L)

Abstract
The course will focus on biological and chemical aspects of sedimentation in marine environments. Marine sedimentation will be traced from coast to deep-sea. The use of stable isotopes palaeoceanography will be discussed. Neritic, hemipelagic and pelagic sediments will be used as proxies for environmental change during times of major perturbations of climate and oceanography.
Objective
- You will understand chemistry and biology of the marine carbonate system
- You will be able to relate carbonate mineralogy with facies and environmental conditions
- You will be familiar with cool-water and warm-water carbonates
- You will see carbonate and organic-carbon rich sediments as part of the global carbon cycle
- You will be able to recognize links between climate and marine carbonate systems (e.g. acidification of oceans and reef growth)
- You will be able to use geological archives as source of information on global change
- You will have an overview of marine sedimentation through time

Content
- carbonates, chemistry, mineralogy, biology
- carbonate sedimentation from the shelf to the deep sea
- carbonate facies
- cool-water and warm-water carbonates
- organic-carbon and black shales
- C-cycle, carbonates, Corg : CO2 sources and sinks
- Carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr
- marine sediments thorough geological time
- carbonates and evaporites
- lacustrine carbonates
- economic aspects of limestone

Lecture notes
no script. scientific articles will be distributed during the course

Literature
We will read and critically discuss scientific articles relevant for "biological and chemical processes in marine and lacustrine systems"

Prerequisites / notice
The grading of students is based on in-class exercises and end-semester examination.

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>651-4057-00L</td>
<td>Climate History and Palaeoclimatology</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Bernasconi, B. Ausin Gonzalez, A. Fernandez Bremer, A. Gill</td>
</tr>
</tbody>
</table>

Abstract
The course "Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in palaeoclimate research.

Objective
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary palaeoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content
Geological system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.

Climate system and earth history: "lessons from the past"
- Cretaceous greenhouse climate
- The Late Paleocene Thermal Maximum (PETM)
- Cenozoic Cooling
- Onset and Intensification of Southern Hemisphere Glaciation
- Onset and Intensification of Northern Hemisphere Glaciation
- Pliocene warmth
- Glacial and Interglacials
- Millennial-scale climate variability during glaciations
- The last deglaciation(s)
- The Younger Dryas
- Holocene climate - climate and societies

Open Choice Modules Geology
Basin Analysis
Basin Analysis: Compulsory Courses

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4231-00L</td>
<td>Basin Analysis</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Willett, T. I. Eglinton, M. Lupker</td>
</tr>
</tbody>
</table>

Abstract
The course discusses the formation and development of different basin types as part of lithosphere geodynamics. It introduces conceptual models and governing physics, with practical application to the study of basin evolution. Techniques for the analysis of subsidence and thermal history are demonstrated. Organic matter, petroleum play, and their biogeochemical investigation are examined.

Objective
Based on the introductory education and practical training during this course, each participant should be able to choose and apply approaches and techniques to own problems of basin analysis, and should be versed to expand their knowledge independently.

In particular, each participant should:
- Develop an intuitive understanding for origin, dynamics, and temporal evolution of basins in a geological / geodynamic context;
- Acquire the necessary theoretical foundation to describe basin evolution quantitatively;
- Be familiar with geological and geophysical methods that are applied to obtain information about rock properties, structural geometry, and thermal and subsidence history of basins;
- Understand the burial and maturation of organic matter in basins, the development of petroleum play, and be acquainted with geochemical methods to study the evolution of biogenic carbon.
The following topics are covered:

- Introduction; classification schemes and types of basins; heat conduction; geotherms;
- The lithosphere; isostasy; rifts and basins due to lithospheric stretching; uniform extension model; modifications to the uniform stretching model; dynamics of rifting.
- Elasticity of the lithosphere; flexural compensation; geometry and analytical description of loads and the resulting deflection; foreland basins; their anatomy;
- Reconstruction of basin evolution; borehole data; porosity loss and decompaction; backstripping; subsidence curves; thermal history and its reconstruction;
- Petroleum play concept; organic production; source rock prediction and depositional environment; petroleum generation, expulsion, migration, alteration; reservoir and traps;
- Carbon cycle; maturation of organic matter; geochemistry of biogenic carbon; biomarkers; analytical techniques
- Overview of other basin types: effects of mantle dynamics, strike-slip basins.

Each week of the course is split in lectures and corresponding practicals, in which the concepts are applied to simplified problems.

Grading of the semester performance is based on submitted practicals (50%) and a final exam (50%). The exam will take place in the time slot of the last practical (18.12.).

Lecture notes
Lecture notes are provided online during the course. They summarize the current subjects week by week, and provide the essential theoretical background.

Literature
Main reference:

Recommended, but not required (available in library).

Supplementary:


Prerequisites / notice
Familiarity with MATLAB is advantageous, but not required.

Basin Analysis: Courses of Choice

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4243-00L</td>
<td>Seismic Stratigraphy and Facies</td>
<td>W</td>
<td>2</td>
<td>3G</td>
<td>G. Eberli</td>
</tr>
</tbody>
</table>

Abstract
Introduction into seismic interpretation for solving geological and environmental problems. A special focus is given to the seismic facies analysis and seismic sequence stratigraphy. In addition, the seismic attributes are explained, which are important for the analysis of paleo-geomorphology and structural deformation.

Objective
1. Acquire techniques for a comprehensive interpretation of seismic sections for solving geologic, tectonic, stratigraphic and environmental problems
2. Correlation of seismic facies to lithologic facies in different sedimentary systems
3. Recognition of structural elements and faults on seismic sections.
4. Learning the techniques of 3D seismic data interpretation
5. Reconstruction of sedimentary history using seismic stratigraphy and facies analysis and core information.
Content

The four day course consists of lectures that are accompanied by a variety of exercises.

Day 1:
Introduction seismic facies analysis with exercise
Seismic resolution
Factors controlling sedimentation
Exercise: Seismic section in Straits of Florida

Day 2:
Seismic attributes and seismic geomorphology
Siliciclastic deltas, shelves and turbidite systems, 2D-3D
Exercise: Seismic section Tarragon Basin
Seismic facies carbonates
Exercise: Seismic section platform margin Great Bahama Bank
Deepwater environments, including cold-water coral habitats

Day 3:
Seismic facies of mixed systems with exercises
Faults and structures on seismic sections
Exercise: Seismic section Golf von Mexiko

Day 4:
Telling ages on seismic section
Seismic stratigraphy and sequence stratigraphy
Exercise: Sequence analysis Straits of Andros
Final discussion

Lecture notes
An original script (110 pages) designed for the class will be distributed at the beginning of the course.

Literature

Books Seismic Facies:

Books Seismic Stratigraphy:
Schlager, W., 1992, Sedimentology and sequence stratigraphy of reefs and carbonate platforms: AAPG Cont. Education course notes #34, pp71.

Prerequisites / notice
Basic knowledge in sedimentology and stratigraphy

Earthquake Seismology

Earthquake Seismology: Compulsory Courses

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4021-00L</td>
<td>Engineering Seismology</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>D. Fäh, M. Pilz</td>
</tr>
</tbody>
</table>

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 576 of 1571
Abstract
This course is a general introduction to the methods of seismic hazard analysis. It provides an overview of the input data and the tools in deterministic and probabilistic seismic hazard assessment, and discusses the related uncertainties.

Objective
This course is a general introduction to the methods of seismic hazard analysis.

Content
In the course it is explained how the disciplines of seismology, geology, strong-motion geophysics, and earthquake engineering contribute to the evaluation of seismic hazard. It provides an overview of the input data and the tools in deterministic and probabilistic seismic hazard assessment, and discusses the related uncertainty. The course includes discussion related to Intensity and macroseismic scales, historical seismicity and earthquake catalogues, ground motion parameters used in earthquake engineering, definitions of the seismic source, ground motion attenuation, site effects and microzonation, and the use of numerical tools to estimate ground motion parameters, both in a deterministic and probabilistic sense.

During the course recent earthquakes and their impacts are discussed and related to existing hazard assessments for the areas of interest.

651-4016-00L  Geophysical Geodesy  W+  3 credits  2G  N. Houlié

Abstract
The course is an introduction to the concepts of geodesy applied to the seismic cycle and to the monitoring of ground deformation.

Objective
a) Students are introduced to various geodetic techniques and to their most famous applications in Earth Sciences;
b) Students are able to independently conceptualize 1) the inter seismic strain accumulation for an earthquake and 2) inflation of a spherical reservoir (i.e. magma chamber of a volcano) or 3) water level change within aquifer. c) Students are then introduced to new techniques linking seismology and geodesy.

Content
1. Plate Tectonics before Space Geodesy;
2. Space geodetic techniques (VBLI, gravity, etc.)
3. The seismic cycle monitoring (Moment release, seismology, Stress transfer)
4. Presentation of GPS and Applications 1 (positioning, rigid plate motions)
5. GPS networks in the world. Development of tectonic geodesy and Applications 2 (Practical on inter-seismic deformation)
6. Presentation of InSAR, psSAR, etc. Applications to earthquake. Post-seismic deformation.
7. Presentation of InSAR, psSAR, etc. Applications to earthquake. Post-seismic deformation.
8. GPS and deformation related to volcanoes (Practical on Mogi source)
9. GPS, Strain, Stress and Plate motion.
10. InSAR applied to subsidence and small deformation.
11. Troposphere sounding. Accuracies of GPS and InSAR.
12. GPS and geodynamics
13. Future of GPS. Future of InSAR.
14. GPS and normal modes?

Lecture notes
Slides. Script in English is planned. PDF of articles cited.

Literature
- Geology and Geophysics equivalent to Bachelor program at ETH
- Math of Bachelor program at ETH

Prerequisites / notice
See webpage
Pre-Requisite:
Of advantage:
Higher Geodesy Basics; Physical Geodesy and Geodynamics I; Seismotectonics

The grading is based on participation, homework sets, and a final oral presentation. There is no final exam.

651-4103-00L  Earthquakes Source Physics  W-  3 credits  2G  S. Wiemer

Abstract
The course unit will be offered again in the autumn semester 2017.

Objective
The aim of the course is to gain a thorough understanding of the physical processes leading to and governing earthquake source ruptures. Finally, this understanding will be applied to analyze a state-of-the-art earthquake physics topic of choice.

Content
We will cover a range of topics, including:
- Earthquake basics: definitions, faults, elastic rebound theory, and source parameters.
- Introduction to elastodynamics: strain, stress, equation of motion.
- Mathematical description of the source:
  - Representation theorem, point and extended sources, source spectra.
  - Energy partitioning.
- Source dynamics: Linear Elastic Fracture Mechanics
- Fault mechanics and friction
- Seismic cycle: inter-, co-, and post-seismic processes
- Aseismic creep and slow slip transients
- Earthquake source inversion and data assimilation
- Recurrence models
- Modeling of dynamic ruptures and seismic cycles

After a theoretical understanding has been acquired, we invite students to apply this knowledge to their topic of preference by presenting a group of state-of-the-art and/or classical papers as a final project. This will require them to understand and evaluate current challenges and state-of-the-art practices in earthquake physics. Additionally, this stimulates participants to improve their skills to:
- critically analyze (to be) published papers
- disseminate knowledge within their own and neighboring research fields
- formulate their opinion, new ideas and broader implications
- present their findings to an audience
- ask questions and actively participate in discussions on new scientific ideas

Lecture notes
Course notes will be made available on a designated course web site. An overview of the discussed principles are available in the three books mentioned below.

Literature
This concerns a bi-yearly course that will be taught again in Fall 2017.

The course will be evaluated in 2 parts:
- a two hours final exam at the end of the course,
- a presentation discussing a topic of chose based on a group of suggested papers

The course is worth 3 credit points, and a satisfactory total grade (4 or better) is needed to obtain 3 ECTS. The final writing exam has a weight of 70% and the presentation weighs for 30%.

The course will be given in English.

Earthquake Seismology: Compulsory Courses
One additional elective course of at least 3KP has to be completed for this Module according to prior agreement with the Subject Advisor (Autumn or Spring Semester).

Geographic Information Systems
The courses of this module are offered by UZH and must be registered at UZH.

Geographic Information Systems: Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4267-00L</td>
<td>Specializing in Geographic Information Science V (University of Zürich)</td>
<td>W+</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: GEO372

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Geographic Information Systems: Courses of Choice
The Courses of Choice are offered by UZH and must be approved by the subject advisor.

Geomagnetics

Geomagnetics: Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4107-00L</td>
<td>Rock and Environmental Magnetism</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>A. M. Hirt</td>
</tr>
</tbody>
</table>

Abstract
The course will cover basic physical theory related to mineral and rock magnetism, measurement techniques, and applications in earth and soil sciences, climatology and biophysics.

Objective
There are two objectives in this course: (1) to acquire an understanding of the physical theory behind the origin of magnetism in a mineral or rock; and (2) to learn how material magnetic properties can be used to study environmental and geologic systems and processes

Content
1. Fundamentals of magnetism
2. Magnetic mineralogy
3. Measurement techniques
4. Time
5. Special Topics: Magnetoclimatology, mass transport, pollution monitoring, biophysics, magnetic properties of nanoscale materials

Lecture notes
Available on-line

Geomagnetics: Courses of Choice
One additional elective course of at least 3KP has to be completed for this Module according to prior agreement with the Subject Advisor (Autumn or Spring Semester).

Glaciology

Glaciology: Compulsory Courses

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>651-3561-00L</td>
<td>Cryosphere</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Funk, M. Huss, K. Steffen</td>
</tr>
</tbody>
</table>

Abstract
This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere components both formally and using examples.

Objective
- Students are able:
  - to qualitatively describe the main components of the cryosphere and their role in the climate system
  - to formally describe the relevant physical processes which determine the state of cryosphere components

Content
Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system. Each part is use to emphasized on one specific physical aspect: material qualities of ice, mass balance and dynamics of glaciers and energy balance of sea ice.

Lecture notes
handouts will be distributed during the teaching semester

Glaciology: Courses of Choice
One additional elective course of at least 3KP has to be completed for this Module according to prior agreement with the Subject Advisor (Autumn or Spring Semester).

Glaciology

Glaciology: Compulsory Courses

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4077-00L</td>
<td>Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)</td>
<td>W</td>
<td>3 credits</td>
<td>1V</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: GEO815

Data: 06.11.2018 12:57   Autumn Semester 2016   Page 578 of 1571
Understanding glaciers and ice sheets with simple physical concepts. Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, glacier seismology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.

After the course the students are able understand and interpret measurements of ice flow, subglacial water pressure and temperature. They will have an understanding of glaciology-related physical concepts sufficient to understand most of the contemporary literature on the topic. The students will be well equipped to work on glacier-related problems by numerical modelling, remote sensing, and field work.

The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).

To identify glaciological hazards and to learn some assessment and mitigation possibilities. Good high school mathematics and physics knowledge required.

#### Lithosphere Structure and Tectonics

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>651-4014-00L</td>
<td>Seismic Tomography</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>E. Kissling, T. Diehl</td>
</tr>
<tr>
<td>651-3521-00L</td>
<td>Tectonics</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>J.P. Burg, E. Kissling</td>
</tr>
</tbody>
</table>

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 579 of 1571
Content

Plate tectonic frame work: earth cooling and mantle-plate interaction, three kinds of plate boundaries and their roles and characteristics, cycle of oceanic lithosphere, longlifety and growth of continents, supercontinents.

Rheology of layered lithosphere and upper mantle.

Obduction systems

Collisions systems

Extensional systems

Basin evolution

Lecture notes

Detailed scriptum in digital form and adominal learning modulus (www.lead.ethz.ch) available on the intranet.

Literature


...
Remote Sensing
The courses of this module are offered by UZH and must be registered at UZH.

Remote Sensing: Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4263-00L</td>
<td>Remote Sensing and Geographic Information Science V (UZH)</td>
<td>W+</td>
<td>5</td>
<td>2V+2U</td>
<td>University lecturers</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO371</td>
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<tr>
<td></td>
<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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</table>

Remote Sensing: Courses of Choice

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4269-00L</td>
<td>Specialisation in Remote Sensing: Spectroscopy of the Earth System (UZH)</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>University lecturers</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO442</td>
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<tr>
<td></td>
<td>Prerequisite: Remote Sensing Methods (UZH Module Code: GEO371)</td>
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<td></td>
<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4257-00L</td>
<td>Specialisation in Remote Sensing: SAR and LiDAR (UZH)</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>University lecturers</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO443</td>
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<tr>
<td></td>
<td>Prerequisite: Remote Sensing Methods (UZH Module Code: GEO371)</td>
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<tr>
<td></td>
<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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Shallow Earth Geophysics

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4109-00L</td>
<td>Geothermal Energy</td>
<td>W+</td>
<td>3</td>
<td>3G</td>
<td>K. F. Evans, P. Bayer, D. Karvounis, M. O. Saar, F. Samrock</td>
</tr>
</tbody>
</table>

Abstract
The course will introduce students to the general principles of Geothermics and is suitable for students who have a basic knowledge of Geoscience or Environmental Science (equivalent of a Bachelor degree).

Objective
To provide students with a broad understanding of the systems used to exploit geothermal energy in diverse settings.

Content
The course will begin with an overview of heat generation and the thermal structure of the Earth. The basic theory describing the flow of heat in the shallow crust will be covered, as will be the methods used to measure it. Petrophysical parameters of relevance to Geothermics, such as thermal conductivity, heat capacity and radiogenic heat productivity, are described together with the laboratory and borehole measurement techniques used to estimate their values. The focus will then shift towards the exploitation of geothermal heat at various depths and temperatures, ranging from electricity and heat production in various types of deep geothermal systems (including high and medium temperature hydrothermal systems, and Engineered Geothermal Systems at depths of 5 km or more), to ground-source heat pumps installed in boreholes at depths of a few tens to hundreds of meters for heating domestic houses.

The subjects covered are as follows:
- Week 1: Introduction. Earth's thermal structure. Conductive heat flow
- Week 3: Temperature measurement. Hydrothermal reservoirs & well productivity
- Week 4: Hydrological characterisation of reservoirs. Drilling, Optimized systems
- Week 5: Petrothermal or Engineered Geothermal Systems
- Week 6: Low-enthalpy systems 1
- Week 7: Low-enthalpy systems 2

Lecture notes
The script for each class will be available for download from the Ilias website no later than 1 day before the class.

Modules from the Engineering Geology Major
Choice from Engineering Geology Required Modules

Modules from the Geophysics Major
Choice from Geophysics Compulsory Modules
Choice from Geophysics Restricted Choice Modules

Modules from the Mineralogy and Geochemistry Major
Choice from the Mineralogy and Geochemistry Restricted Choice Modules

Modules from the Major Geology Restricted Choice Modules
Choice from the Geology Restricted Choice Modules

Major in Engineering Geology

Compulsory Modules Engineering Geology

Engineering Geology: Fundamentals

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4025-00L</td>
<td>Rock Mechanics and Rock Engineering</td>
<td>W+</td>
<td>4</td>
<td>4V+2U</td>
<td>F. Amann, R. Jalali, K. Leith, M. Perras</td>
</tr>
</tbody>
</table>

Abstract
This course focuses on the principles (fundamentals) and basic concepts of rock mechanics and rock engineering (e.g., tunnelling, rock slope stability).

Objective
The course aims to introduce the fundamentals and basic concepts of rock mechanics and generic rock engineering. The student shall understand how rocks behave at different scales, under various artificial loads and in the shallow subsurface (a few km below ground). The link between rock mechanics, geology, hydrogeology and tectonics (i.e., the conditions under which the rock formed) will be clearly established.

The student shall understand basic principles of rock mechanics and rock engineering. In addition, the student shall learn how to carry out laboratory tests, to interpret these tests and to apply the results from lab and field investigations to simple engineering problems. This knowledge is required for subsequent integration courses (Landslide Analysis and Hazard Mitigation; Engineering Geology of Underground Excavations).

Content
This course focuses on the principles (fundamentals) and basic concepts of rock mechanics and generic rock engineering. The behavior of different rock types is studied with laboratory investigations which are linked to the theoretical aspects discussed in lectures and applied in exercises. The course is compulsory for the MSc Eng Geol. The applications of rock mechanical principles and rock engineering methods are extensively covered in subsequent courses.

Lecture notes
Written course documentation available on our homepage: www.engineeringgeology.ethz.ch

651-4033-00L Soil Mechanics and Foundation Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4033-00L</td>
<td>Soil Mechanics and Foundation Engineering</td>
<td>W+</td>
<td>4</td>
<td>3V+2U</td>
<td>M. Perras, A. Wolter, M. Stolz</td>
</tr>
</tbody>
</table>

Abstract
The course presents the principles of soil mechanics and soil behaviour characteristics and its applications in geotechnical structures and systems. It is based on more descriptive courses on Engineering Geology within the BSc Geol. Program and is a compulsory prerequisite for other courses within the MSc Eng. Geol. program.

Objective
Understanding the principles of soil behaviour and the fundamentals of geotechnical practices in soils.

Ability to communicate with geotechnical engineers.

Content
Soil Mechanics:
Fundamental concepts of strength and deformation of different soils. Introduction to geotechnical calculations
Significance of (ground)water
Geotechnical Engineering in Soils:
Evaluation of geotechnical scenarios, handling of forecast uncertainties, relation of soil properties and soil composition, interactions between soil and building,
standard construction methods in soils (foundations, slopes, dams and levees),
requirements for the geotechnical prognosis

Lecture notes
This lecture is supported by the textbook: "Geotechnical Engineering" by Donald P. Coduto, 2nd edition, 2011; ISBN-13: 978-0-13-135425-8

Prerequisites / notice
Courses must be completed:
Introduction to Engineering Geology (BSc level)
Introduction to Groundwater
Sedimentology and Quaternary deposits
Principles of Physics

Courses recommended:
Eng Geol Site Investigations
Eng Geol Field Course I (soils)
Clay Mineralogy

Groundwater

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4023-00L</td>
<td>Groundwater</td>
<td>W+</td>
<td>4</td>
<td>3G</td>
<td>M. O. Saar, X.Z. Kong</td>
</tr>
</tbody>
</table>

Abstract
The course provides an introduction into quantitative analysis of groundwater flow and solute/heat transport. It is focussed on understanding, formulating, and solving groundwater flow and solute/heat transport problems.

Objective
a) Students understand the basic concepts of groundwater flow and solute/heat transport processes and boundary conditions.

b) Students are able to formulate simple, practical groundwater flow and solute/heat transport problems.

c) Students are able to understand and apply simple analytical and/or numerical solutions to fluid flow and solute/heat transport problems.
Content

1. Introduction to groundwater problems. Concepts to quantify properties of aquifers.
2. Flow equation. The generalised Darcy law.
3. The water balance equation.
5. Analytical solutions to flow problems I
6. Analytical solutions to flow problems II
7. Finite difference solution to flow problems.
12. Analytical solutions to transport problems I.
13. Analytical solutions to transport problems II

Lecture notes
Handouts of slides.

Literature
de Marsily G., Quantitative Hydrogeology, Academic Press, 1986

Engineering Geology: Methods

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
651-4065-00L| Geological Site Investigations | W+   | 3     | 3G    | M. Ziegler, A. Manconi |

Abstract
This course introduces students to the methods used in characterising, developing or monitoring geotechnical engineering project sites. Measurements, tools and analyses are described that are relevant to determining the geologic conditions at a site as well as deformations that occur under natural or construction conditions.

Objective
This course aims to introduce the general procedures taken during a engineering geological site investigation. Students who complete the course should be able to design a site investigation program of measurements based on information from initial desk studies, and to analyse, integrate and interpret data from the measurement program.

Content
The methods that are routinely employed in site investigations will be described focusing on their applicability in different geologic environments. The limitations of the data in constraining the parameters of interest will be addressed together with problems of interpretation and cost-versus-information value. Specific topics addressed include drilling, coring, sampling, borehole testing, geophysical methods used in engineering geology, satellite, air- and ground-based surface and displacement monitoring (photogrammetry, LIDAR and Radar), and in-situ deformation measurement methods.

Lecture notes
Lecture notes will be available for download 1-2 days before each class.

Literature
Online (ETH): http://www.icevirtuallibrary.com/content/book/100017

Supplemental literature will be suggested and made available during the course.

Engineering Geology: Integration

Courses for this Module take place in spring semester.

Engineering Geology: Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
651-4071-00L| Industrial Internship      | W+   | 12    | 32P   | B. Oddsson, E. Kreuzer |

Prerequisites: successful participation in all 3 compulsory modules of the Major in Engineering Geology (Fundamentals, Methods and Integration).
The Industrial Internship of the Eng Geol Major should take place in the second MSc year after consultation with Dr. Ernst Kreuzer. Detailed regulations of this practical are published on the Eng Geol Website.
**Major in Geophysics**

**Compulsory Modules Geophysics**

**Geophysics: Methods I**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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</tr>
</thead>
<tbody>
<tr>
<td>651-4005-00L</td>
<td>Geophysical Data Processing</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>C. V. Cauzzi</td>
</tr>
</tbody>
</table>

**Abstract**

This course presents fundamental digital signal processing and filter theory with a focus on geophysical applications.

**Objective**

The goal of the course is to provide an understanding of the principles of digital signal processing and filter theory. Form: two hours lecture with two hours of computer based exercises per week over 7 weeks.

**Content**

- Analog-digital conversion: dynamic range and resolution; Dirac-impulse, step function; Laplace transformation; Z-transformation;
- Differential equations of linear time-invariant systems; Examples: seismometer and RC-filter; Impulse response and transfer function;
- Frequency selective filters: example Butterworth filters; Digital filters: impulse invariance and bilinear transformation; Inverse filters; Response spectra.

**Lecture notes**

Lecture notes will be made available for download from the website of the course.

**Literature**

The class follows no single book. A list of relevant texts will be given in class.

**Prerequisites / notice**

Students must bring their own laptop in class for Matlab exercises.

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**Geophysical Fluid Dynamics**

**Geophysics: Methods II**

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4001-00L</td>
<td>Geophysical Fluid Dynamics</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>J. A. R. Noir</td>
</tr>
</tbody>
</table>

**Abstract**

Fluid mechanics is one of the fundamental building blocks of modern geophysics. This course aims to provide the students with the basics tools used in fluid dynamics studies of geophysical-astrophysical problems. The course is a combination of lectures, exercises and demo experiments to present the same concepts in various forms.

**Objective**

The goal of this course is to develop familiarity with basic fluid dynamical concepts relevant to geophysical and astrophysical problems.

**Content**

- (i) Basic concepts.
- (ii) Conservation Laws.
- (iii) Dynamical similarity and scale analysis.
- (iv) The inviscid approximation.
- (v) Streamlines-Streamfunctions.
- (vi) Elements of boundary layer theory - Application to viscous boundary layer.
- (vii) Vorticity-Concept and Examples.
- (viii) Introduction to rotating fluid.
- (ix) Viscous boundary layer in rotating fluid.
- (x) Non-rotating thermal convection.
- (xi) Introduction to rotating thermal convection.

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**Literature**

Taras Gerya, Introduction to Numerical Geodynamic Modelling, Cambridge University Press 2010

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**GRADING**

will be based on weekly programming homeworks (50%) and a term project (50%) to develop an application of their choice to a more advanced level.

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**Autumn Semester 2016**  
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Continuum Mechanics

In this course, students learn crucial partial differential equations (conservation laws) that are applicable to any continuum including the Earth's mantle, core, atmosphere and ocean. The course will provide step-by-step introduction into the mathematical structure, physical meaning and analytical solutions of the equations. The course has a particular focus on solid Earth applications.

The goal of this course is to learn and understand few principal partial differential equations (conservation laws) that are applicable for analysing and modelling of any continuum including the Earth's mantle, core, atmosphere and ocean. By the end of the course, students should be able to write, explain and analyse the equations and apply them for simple analytical cases. Numerical solving of these equations will be discussed in the Numerical Modelling I and II course running in parallel.

A provisional week-by-week schedule (subject to change) is as follows:

Week 1: The continuity equation
Exercise: Computing the divergence of velocity field.

Week 2: Density and gravity
Exercise: Computing density, thermal expansion and compressibility from an equation of state.

Week 3: Stress and strain
Exercise: Analysing strain rate tensor for solid body rotation.

Week 4: The momentum equation

Week 5: Viscous rheology of rocks
Theory: Solid-state creep of minerals and rocks as themajor mechanism of deformation of the Earths interior. Dislocation and diffusion creep mechanisms. Rheological equations for minerals and rocks. Effective viscosity and its dependence on temperature, pressure and strain rate. Formulation of the effective viscosity from empirical flow laws.
Exercise: Deriving viscous rheological equations for computing effective viscosities from empirical flow laws.

Week 6: The heat conservation equation
Exercise: steady state temperature profile in case of channel flow.

Week 7: Elasticity and plasticity

GRADING will be based on homeworks (30%) and oral exams (70%).
The course explains the principles and assumptions used in seismology. It provides the tools to solve basic seismological problems. The course includes the theorems in dynamic elasticity, the formulation with potentials, Greens function, elastic waves from point dislocations sources, moment tensors, 1D, 2D, and 3D wave propagation problems, reflection and transmission at plane boundaries, and surface waves in a vertically heterogeneous medium.

**Seismotectonics**

**Abstract**

If you’re interested in knowing more about the relationship between seismicity and plate tectonics, this is the course for you. (If you’re not that interested, but yr program of study requires that you complete this course, this is also the course for you.)

**Objective**

By the conclusion of this course, we hope that you:

- have a solid understanding of stress and strain and tensor representations;
- have a feeling for what rheology is and why it is important;
- have a more sophisticated understanding of the relationship b/w plate tectonics and eqks;
- understand eqk source representations of varying complexity;
- understand eqks in the context of different tectonic settings;
- understand why we can’t predict eqks; and
- understand that “modern science is... a set of research directions rather than a collection of nuggets of established truth.”

**Content**

To begin our series of 14 meetings, we will review fundamentals of continuum mechanics and tensor analysis; our goal is to help you understand deformation from the scale of contornach in the classroom to the scale of plate tectonics. We will tell you about several ways to approximately represent an earthquake source; we’ll present these in order of increasing sophistication. We’ll discuss a currently-popular theory to explain earthquake triggering. We’ll talk about the conceptual connections between earthquakes and tectonic deformation. You will enjoy (at least) two computer exercises.

Discussed: stress and deformation in the Earth; stress and strain tensors; rheology and failure criteria; fault stresses, friction and effects of fluids; stable and unstable sliding; earthquake focal mechanisms; relationship between stress fields and focal mechanisms; seismic moment and moment tensors; relationship between moment- and deformation tensors; crustal deformation from seismic, geologic, and geodetic observations; earthquake stress drop, scaling, and source parameters; earthquake induced stress changes; global earthquake distribution; current global earthquake activity; different seismotectonic regions; examples of earthquake activity in different tectonic settings, such as in subduction zones, California, the Mediterranean, and in Switzerland.

**Literature**


**Prerequisites / notice**

You should have at least a foggy recollection of calculus.

**Physics of the Earth’s Interior**

**Planetary Physics and Chemistry**

**Abstract**

This course aims to give a physical understanding of the formation, structure, dynamics and evolution of planetary bodies in our solar system and also apply it to ongoing discoveries regarding planets around other stars. Students will practice making quantitative calculations relevant to various aspects of these topics through weekly homeworks.

**Objective**

The goal of this course is to enable students to understand current knowledge and uncertainties regarding the formation, structure, dynamics and evolution of planets and moons in our solar system, as well as ongoing discoveries regarding planets around other stars. Students will practice making quantitative calculations relevant to various aspects of these topics through weekly homeworks.

The following gives an overview of the course content and approximate schedule (subject to change).

<table>
<thead>
<tr>
<th>Hours</th>
<th>Topics</th>
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<tbody>
<tr>
<td>1-2</td>
<td>Introduction</td>
</tr>
<tr>
<td>3-4</td>
<td>Orbital dynamics and Tides</td>
</tr>
<tr>
<td>5-6</td>
<td>Solar heating and Energy transport</td>
</tr>
<tr>
<td>7-8</td>
<td>Planetary atmospheres</td>
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<tr>
<td>9-10</td>
<td>Planetary surfaces</td>
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<td>11-12</td>
<td>Planetary interiors</td>
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<tr>
<td>13-14</td>
<td>Asteroids and Meteorites</td>
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<tr>
<td>15-16</td>
<td>Comets</td>
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<tr>
<td>17-18</td>
<td>Planetary rings</td>
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<tr>
<td>18-20</td>
<td>Magnetic fields and Magnetospheres</td>
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<td>21-22</td>
<td>The Sun and Stars</td>
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<tr>
<td>23-24</td>
<td>Planetary formation</td>
</tr>
<tr>
<td>25-26</td>
<td>Exoplanets and Exobiology</td>
</tr>
<tr>
<td>27-28</td>
<td>Review</td>
</tr>
</tbody>
</table>

**Literature**

Slides and scripts will be posted at the moodle site:https://moodle-app2.let.ethz.ch/course/view.php?id=2559

**Applied Geophysics**

**Applied Geophysics: Compulsory Courses**

Fundamental Planetary Science, by Jack J. Lissauer & Imke de Pater (paperback), Cambridge University Press, 2013. (books.ch Fr64.90, amazon.co.uk £35.00, amazon.de €38.61, amazon.com $49.26).

The compulsory courses take place in spring semester.

➡️➡️ Applied Geophysics: Courses of Choice
The compulsory Courses for the Module Applied Geophysics take place in Spring Semester. One additional elective course of at least 3KP has to be completed for this Module according to prior agreement with the Subject Advisor of the Geophysics Major (Autumn or Spring Semester).

➡️ Major in Mineralogy and Geochemistry
➡️➡️ Compulsory Module in Analytical Methods in Earth Sciences
Students have to complete 6 credits in part A (microscopy courses), and 6 credits in part B (methods).

➡️➡️ Microscopy Courses

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4028-00L</td>
<td>Physical Properties of Minerals</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>E. Reusser</td>
</tr>
</tbody>
</table>

Abstract
Physical properties of minerals, e.g. electrical properties, elasicitcal properties are discussed. The effect of the crystal symmetry on the symmetry of physical properties as well as the mathematical formulation of the physical properties are major topics.

➡️➡️ Analytical Methods Courses

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<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>651-4039-00L</td>
<td>Thermodynamics Applied to Earth Materials</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>J. Connolly</td>
</tr>
</tbody>
</table>

Abstract
This course develops the thermodynamic concepts necessary to predict phase equilibria and to compute physical properties from thermodynamic data.

Objective
To provide students with the conceptual and practical skills necessary to implement thermodynamic models and data as provided in the earth science literature. The computer software package Maple is relied upon to allow students to solve realistic problems without the distraction of mathematical details.

Content
Elementary concepts (1st and 2nd Laws; composition, state and extent); stability criteria; Legendre transforms; Maxwell relations and other manipulations of thermodynamic functions; calculation of Gibbs energy for a pure solid; simple solution models; order-disorder solution models; reciprocal solution models; equations of state for molecular fluids; free energy minimization.

This course is neither an introduction to computer methods for calculating petrological phase equilibria nor an introduction to phase diagram methods.

Prerequisites / notice
The grade for the course is based on exercises assigned as homework.

Some familiarity with elementary thermodynamics (phase rule, reactions) and mathematics (differentiation, integration) is assumed. Experience with Maple or comparable programs such as Mathematica is helpful.

➡️➡️ Mineralogy and Petrology: Compulsory Courses

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4063-00L</td>
<td>X-ray Powder Diffraction</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>L. M. Plötze</td>
</tr>
</tbody>
</table>

Number of participants limited to 12.

Abstract
In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for qualitative and quantitative mineral composition as well as crystallographic parameters.

Objective
Upon successful completion of this course students are able to:
- describe the principle of X-ray diffraction analysis
- carry out a qualitative and quantitative mineralogical analysis independently,
- critically assess the data,
- communicate the results in a scientific report.

Content
Fundamental principles of X-ray diffraction
Setup and operation of X-ray diffractometers
Interpretation of powder diffraction data

Lecture notes
Selected handouts will be made available in the lecture

Literature


Prerequisites / notice
The course includes a high portion of practical exercises in sample preparation as well as measurement and evaluation of X-ray powder diffraction data.

Own sample will be analysed qualitatively and quantitatively. Knowledge in mineralogy of this system is essential.

The lecture course is limited to 12 participants.

➡️➡️ Mineralogy and Petrology: Courses of Choice

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<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>651-4223-00L</td>
<td>Phase Petrology</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>L. Tajcmanová</td>
</tr>
</tbody>
</table>

Abstract
A comprehensive introduction to heterogeneous phase equilibria in the geosciences.

Objective
The aim of the course is to give insight into processes that lead to the formation of magmatic and metamorphic rocks.
Content

The course will give an introduction to phase petrology and its application to magmatic and metamorphic systems. Further, the course will give an introduction to thermobarometry of mineral assemblages. The origin and interpretation of microstructures and chemical zonation in rocks will be discussed. We will also touch kinetics of rock forming processes and the role of fluids during the lectures.

The specific topics will involve:

Mineral reactions and chemical equilibrium in metamorphic and magmatic rocks, recalculiation of rock and mineral analyses, mineral modes, P-T-X relations.

Literature

1) the blue book by F Spear 1993 Metamorphic phase equilibria and pressure-temperature-time paths. MSA Monograph

2) Principles of Metamorphic Petrology: Ron H. Vernon, Geoffrey Clarke

651-4233-00L Geotectonic Environments and Deep Global Cycles

Abstract

This course addresses master students interested in an integral view of processes operating in various tectonic environments, most specifically divergent and convergent plate margins

651-4097-00L Applied Mineralogy and Non-Metallic Resources I

Abstract

Geological and mineralogical aspects to important non-metallic mineral resources. Industrial use of specific mineral resources as well as economic, strategic and environmental aspects are discussed. Examples from all over the world with a specific focus on the non-mineral mineral resources potential in Switzerland.

Objective

Students will learn to understand the use of non-metallic mineral resources from a geological and mineralogical point of view as well as from an industrial, technical and strategic (political) point of view. Environmental aspects on the worldwide use of non-metallic mineral resources are discussed. A special focus will be given on the situation in Switzerland.

Content

Teaching, case-studies and excursions (raw-material industry).

Course "Applied mineralogy and non-metallic resources I" (autumn/winter semester):

- Non-metallic resources. Occurrences, geology, extraction, properties, fabrication and use. Industrial aspects, (new) technologies, market, stock, situation, reserves & resources, trends and development, environmental aspects, law.

- Chapters: e.g. coal/charcoal, graphite, diamond, fullerene; oil/gas (oil- and tarsands, oil-shists); phosphates/nitrates; aluminum (bauxite, corundum); salt; carbonates; titanium; clay and clay minerals; sulphur; gypsum/anhydrite; fluorite; asbestos; talc; micas; rare earth elements.

Course "Applied mineralogy and non-metallic resources II" (fall/summer semester):


- Chapters: e.g. stone industry - technical aspects of building stones, properties, weathering, treatment, quarries, products. Crushed stones - quarries, products, planning, environment. Gravel an sand - resources/reserves, environment (protection/law), alternative products (substitution). Cement and concrete (geological resources, prospection, fabrication, environment).

Lecture notes

Will be given according to the lessons. Partially integration of e-learning tools.

Literature


Petrology and Volcanology

Petrology and Volcanology: Compulsory Courses

The compulsory courses take place in spring semester.

Petrology and Volcanology: Courses of Choice

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<tr>
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Abstract

In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for qualitative and quantitative mineral composition as well as crystallographic parameters.

Objective

Upon successful completion of this course students are able to:

- describe the principle of X-ray diffraction analysis
- carry out a qualitative and quantitative mineralogical analysis independently,
- critically assess the data,
- communicate the results in a scientific report.

Content

Fundamental principles of X-ray diffraction

Setup and operation of X-ray diffractometers

Interpretation of powder diffraction data

Lecture notes

Selected handouts will be made available in the lecture

Literature


Prerequisites / notice

The course includes a high portion of practical exercises in sample preparation as well as measurement and evaluation of X-ray powder diffraction data.

Own sample will be analysed qualitatively and quantitatively. Knowledge in mineralogy of this system is essential.

The lecture course is limited to 12 participants.

651-4233-00L Geotectonic Environments and Deep Global Cycles

Abstract

This course addresses master students interested in an integral view of processes operating in various tectonic environments, most specifically divergent and convergent plate margins
### Mineral Resources

#### Mineral Resources: Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>651-4097-00L</td>
<td>Applied Mineralogy and Non-Metallic Resources I</td>
<td>W*</td>
<td>3 credits</td>
<td>2G</td>
<td>R. Kündig, C. Bühler</td>
</tr>
</tbody>
</table>

**Abstract**
Geological and mineralogical aspects to important non-metallic mineral resources. Industrial use of specific mineral resources as well as economic, strategic and environmental aspects are discussed. Examples from all over the world with a specific focus on the non-mineral mineral resources potential in Switzerland.

**Objective**
Students will learn to understand the use of non-metallic mineral resources from a geological and mineralogical point of view as well as from industrial, technical and strategic (political) point of view. Environmental aspects on the worldwide use of non-metallic mineral resources are discussed. A special focus will be given on the situation in Switzerland.

**Content**
Teaching, case-studies and excursions (e.g. raw-material industry).

Course “Applied mineralogy and non-metallic resources I” (autumn/winter semester):
Non-metallic resources. Occurrences, geology, extraction, properties, fabrication and use. Industrial aspects, (new) technologies, market, stock, situation, reserves & resources, trends and development, environmental aspects, law.

Chapters: e.g. coal/carbon (coal, graphite, diamond, fullerene); oil/gas (oil- and tarsands, oil-shists); phosphates/nitrates; aluminum (bauxite, corundum); salt; carbonates; titanium; clay and clay minerals; sulphur; gypsum/anhydrite; fluorite; asbestos; talc; micas; rare earth elements.

Course “Applied mineralogy and non-metallic resources II” (fall/summer semester):

Chapters: e.g. Stone industry - technical aspects of building stones, properties, weathering, treatment, quarries, products. Crushed stones - quarries, products, planning, environment. Gravel an sand - resources/reserves, environment (protection/law), alternative products (substitution). Cement and concrete (geological resources, prospection, fabrication, environment).

**Lecture notes**
Will be given according to the lessons. Partially integration of e-learning tools.

**Literature**

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</thead>
<tbody>
<tr>
<td>651-4037-00L</td>
<td>Ore Deposits I</td>
<td>W*</td>
<td>3 credits</td>
<td>2G</td>
<td>C. A. Heinrich</td>
</tr>
</tbody>
</table>

**Abstract**
Principles of hydrothermal ore formation, using base metal deposits (Cu, Pb, Zn) in sedimentary basins to explain the interplay of geological, chemical and physical factors from global scale to sample scale. Introduction to orthomagmatic ore formation (mostly Cr, Ni, PGE).

**Objective**
Understanding the fundamental processes of hydrothermal and magmatic ore formation, recognising and interpreting mineralised rocks in geological context

**Content**

(b) Introduction to orthomagmatic ore formation. Chromite, Ni-Cu sulphides and PGE in layered mafic intrusions. Distribution coefficients between silicate and sulphide melts. Carbonattes and pegmatite deposits.

**Lecture notes**
Notes handed out during lectures

**Literature**
Extensive literature list distributed in course

**Prerequisites / notice**
2 contact hours per lecture / week including lectures, exercises and practical study of samples, and small literature-based student presentations. Supplementary contact for sample practicals and exercises as required. Credits and mark based on participation in course (exercises, 50%) and 1h written exam in the last lecture of the semester (50%).

#### Mineral Resources: Courses of Choice

<table>
<thead>
<tr>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4069-00L</td>
<td>Fluid and Melt Inclusions: Theory and Practice</td>
<td>W</td>
<td>3 credits</td>
<td>3P</td>
<td>C. A. Heinrich, T. Driesner, O. Laurent</td>
</tr>
</tbody>
</table>

**Abstract**
Block course involving lectures, exercises and practical application of inclusion petrography, microthermometry, Raman and LA-ICPMS microanalysis

**Objective**
Practical ability to carry out a meaningful fluid or melt inclusion study in the fields of geochemistry, petrology or resource geology, involving problem definition, research planning, quantitative measurements using a combination of techniques, critical interpretation and correct documentation of results.

**Lecture notes**
Goldstein and Reynolds (1994): CD available for in-house use

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</thead>
<tbody>
<tr>
<td>651-4221-00L</td>
<td>Numerical Modelling of Ore Forming Hydrothermal Processes</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>T. Driesner</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to computer tools for the simulation of hydrothermal processes. This includes fluid flow modelling and thermodynamic modelling of hydrothermal reactions. The computer programs are handed out to the students and can be run on normal PCs. No programming knowledge is necessary.

**Objective**
Learn how to use the simulation programs HYDROTHERM and HCh to explore how hydrothermal systems work.
Introduction to computer tools for the simulation of hydrothermal processes: HYDROTHERM for fluid flow simulations, HCH for thermodynamic modeling. While learning the respective computer programs is an essential part of the course, the emphasis will be on using these tools to learn how the physics and chemistry of hydrothermal system actually work.

Computer programs and course material will be distributed during the course.


Objective
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary paleoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content
Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.

Geological time, stratigraphy, geological archives, climate archives, paleoclimate proxies
Climate through geological time: “lessons from the past"
Cretaceous greenhouse climate
The Late Paleocene Thermal Maximum (PETM)
Cenozoic Cooling
Onset and Intensification of Southern Hemisphere Glaciation
Onset and Intensification of Northern Hemisphere Glaciation
Pliocene warmth
Glacial and Interglacials
Millennial-scale climate variability during glaciations
The last deglaciation(s)
The Younger Dryas
Holocene climate - climate and societies

651-4225-00L Topics in Geochemistry W 3 credits 2G S. Bernasconi, G. Bernasconi-Green
Abstract
This course aims to present and discuss advanced topics in geochemistry based on the critical reading of research papers. Themes will vary from year to year and suggestions from students are welcome. The format of the course will be: one or more lectures introducing a theme, followed by a presentation of one or more papers by a student or group of students.
Objective
The goal of the course is discuss topics in advanced geochemistry which were not covered in other general and specialized geochemistry courses. In addition, we aim at training the student's ability to critically evaluate research papers and to summarize the findings concisely in an oral presentation.
Content
Themes will vary from year to year and suggestions from students are welcome.
Some possible topics are:
- Organic geochemistry.
- Isotope geochemistry of organic matter: carbon, hydrogen and nitrogen.
- Multiply-substituted isotopologues.
- Mass-independent fractionations.
- Mass transfer and isotopes in modern and ancient ocean-floor hydrothermal systems and subduction zone environments.
- Noble gas geochemistry: terrestrial and extraterrestrial applications

Lecture notes
None
Literature
Will be identified based on the chosen topic.

651-4010-00L Planetary Physics and Chemistry W 3 credits 2G P. Tackley
Abstract
This course aims to give a physical understanding of the formation, structure, dynamics and evolution of planetary bodies in our solar system and also apply it to ongoing discoveries regarding planets around other stars.
Objective
The goal of this course is to enable students to understand current knowledge and uncertainties regarding the formation, structure, dynamics and evolution of planets and moons in our solar system, as well as ongoing discoveries regarding planets around other stars. Students will practice making quantitative calculations relevant to various aspects of these topics through weekly homeworks.

The following gives an overview of the course content and approximate schedule (subject to change).

<table>
<thead>
<tr>
<th>Hours</th>
<th>Topics</th>
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<tbody>
<tr>
<td>1-2</td>
<td>Introduction</td>
</tr>
<tr>
<td>3-4</td>
<td>Orbital dynamics and Tides</td>
</tr>
<tr>
<td>5-6</td>
<td>Solar heating and Energy transport</td>
</tr>
<tr>
<td>7-8</td>
<td>Planetary atmospheres</td>
</tr>
<tr>
<td>9-10</td>
<td>Planetary surfaces</td>
</tr>
<tr>
<td>11-12</td>
<td>Planetary interiors</td>
</tr>
<tr>
<td>13-14</td>
<td>Asteroids and Meteorites</td>
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<tr>
<td>15-16</td>
<td>Comets</td>
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<tr>
<td>17-18</td>
<td>Planetary rings</td>
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<tr>
<td>19-20</td>
<td>Magnetic fields and Magnetospheres</td>
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<tr>
<td>21-22</td>
<td>The Sun and Stars</td>
</tr>
<tr>
<td>23-24</td>
<td>Planetary formation</td>
</tr>
<tr>
<td>25-26</td>
<td>Exoplanets and Exobiology</td>
</tr>
<tr>
<td>27-28</td>
<td>Review</td>
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</tbody>
</table>

Lecture notes
Slides and scripts will be posted at the moodle site:https://moodle-app2.let.ethz.ch/course/view.php?id=2559

Literature
It is recommended but not mandatory to buy one of these books:
Fundamental Planetary Science, by Jack J. Lissauer & Imke de Pater (paperback), Cambridge University Press, 2013. (books.ch Fr64.90, amazon.co.uk £35.00, amazon.de €38.81, amazon.com $49.26).

651-4235-00L Marine Geology and Geochemistry W 3 credits 2G G. Bernasconi-Green
Abstract
Introduction to oceanographic methods and international research programs in marine geology and an overview of physical, chemical and biological processes in modern marine environments.

Objective
This course aims at giving an overview of oceanographic methods and an understanding of physical, chemical and biological processes in modern marine environments. This course will combine lectures and student participation. Student presentations are based on critical reading of research papers and integration of data and results from international oceanographic programs and ocean drilling.

Content
Specific topics will be chosen to examine processes of crustal formation, alteration, mass transfer and biological activity in mid-ocean ridge, continental margin and subduction zone settings, with consideration of data and new results obtained from international oceanographic programs and from DSDP, ODP and IODP drilling.

Lecture participation and discussions are based on critical reading of research papers, use of internet-based data, and web-based cruise results. Requirements to obtain credit points are oral or poster presentations and a short written summary of selected themes.

Lecture notes
No formal script will be distributed. Handouts will be given, where necessary. These will consist of the most important diagrams presented in the lectures. The students are expected to take their own notes and consult the literature for more details.

Literature
Lists of literature relevant to the selected topics will be handed out in the course.

Prerequisites / notice
This course is offered every 2 years.

651-4229-00L Advanced Geochronology W 3 credits 2G A. Quadt Wykradt-Hüchtenbruck, H. Busemann, B. Ellis, M. Guillong, A. Liati

Objective
The purpose of this lecture is to provide a comprehensive overview of: a) the different radiometric methods in Geology, the different dating tasks and the constraints put by the complexity of natural systems, including dating by cosmogenic nuclides, b) the various analytical tools available today for radiometric dating, their advantages and disadvantages, c) the use of noble gases in Geochemistry and d) detailed description of case studies, as examples of approach of a number of geological problems and interpretation of the data.

Content
The content of this lecture is summarised as follows:

Anthi Liati:
- Ion microprobes - U-Pb SHRIMP dating (zircon, sphene, rutile, monazite)
- Dating metamorphic rocks
- Combined geochronology and petrology: subduction and exhumation rates
- Tracing the timing of mantle and crustal events via zircon-dating in mantle xenoliths: Two case studies: South Namibia, Kilbourne Hole (New Mexico)

Henner Busemann:
- Noble gas geo- and cosmochemistry
- Surface exposure dating with cosmogenic nuclides
- Carbon-14 dating and U-Th-He thermochronology
- Visit of the radiogenic and noble gas isotope laboratories of IGMR

Albrecht von Quadt:
- Analytical tools and applications to radiogenic isotopes (basics about TIMS, LA-ICP-MS-MC)
- Dating magmatic rocks and ore deposits (porphyry, epithermal Cu-Au-(Mo) deposits)
- U-Pb, Re-Os, Pb-Pb methods - HI tracing of zircons
- Geochronology and geochemistry of magmatic systems

Marcel Guillong:
- LA-ICP-MS as the method of choice for dating, in comparison to other methods (Ion-probe, TIMS, ...)
- Data reduction in LA-ICP-MS: from measured counts per seconds to the final age of a sample, with hands-on example.
- The challenge to date very young Zircons, with an example from Kos.

Ben Ellis:
- Ar-Ar dating techniques
- Ar-Ar dating of volcanic rocks

Lecture notes
Script (for part of the lecture), partly power point presentations (in the web) and partly copies of power point transparencies.

Literature
- http://www.elementsmagazine.org/archives/index.html; see February 2013

Open Choice Modules Mineralogy and Geochemistry

Modules from the Geology Major
Choice from the Geology Restricted Choice Modules
Choice from the Geology Open Choice Modules

Modules from the Engineering Geology Major
Modules from the Engineering Geology Compulsory Modules

Modules from the Geophysics Major
Modules from the Geophysics Compulsory Modules
Modules from the Geophysics Restricted Choice Modules

Restricted Choice Module of Mineralogy and Geochemistry
Choice from Mineralogy and Geochemistry Restricted Choice Modules

Electives
Courses can be chosen from the complete offerings of the ETH Zurich and University of Zurich (according to prior agreement with the subject advisor).

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<tbody>
<tr>
<td>651-1615-00L</td>
<td>Colloquium Geophysics</td>
<td>W</td>
<td>1</td>
<td>1K</td>
<td>A. Obermann</td>
</tr>
</tbody>
</table>
## Introduction to Scanning Electron Microscopy (W 1 credit 2G K. Kunze, L. Martin)

**Objective**: Introduction in scanning electron microscopy and microanalysis. Obtain practical experience in operating a SEM. This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of electron optics, interaction of electrons with matter, production of X-rays, interaction of X-rays with matter. Detection of X-rays. Laboratory work in the field of Earth sciences. Physical principles of electron optics, interaction of electrons with matter, production of X-rays, interaction of X-rays with matter. Detection of X-rays. Laboratory work in the field of Earth sciences.

**Content**: Functional principles and operation modes of a scanning electron microscope. Methods and application fields for imaging (SE, BSE, FSE, AE, CL), X-ray spectroscopy (EDX), Electron diffraction (EBSD, Channeling, Orientation Imaging). Methods for sample preparation. Practical exercises. Scripts and operation manuals are provided during the course. Additional material will be provided by the lecturers.

**Prerequisites / notice**: Full day block course after the end of HS.

## Electron Microprobe Course (W 3 credits 4G E. Reusser)


**Content**: Physical principles of electron optics, interaction of electrons with matter, production of X-rays, interaction of X-rays with matter. Detection of X-rays. Laboratory work in the field of Earth sciences.

**Lecture notes**: Kursunterlagen


**Prerequisites / notice**: Prerequisite: Analytical methods in Petrology and Geology (651-4055-00L).


**Objective**: A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

**Content**: This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, structural geology and structural chemistry will be reported.

**Lecture notes**: Englisch

- Erni: Aberration-corrected imaging in transmission electron microscopy, Imperial College Press (2010, and 2nd ed. 2015)

## Exploration and Environmental Geophysics (W 4 credits 3V F. Broggi, J. Doetsch)

**Objective**: Overview and understanding of the most important geophysical methods: Potential field methods (Gravimetrics and Magnetics), Electrical and electromagnetic methods, Refraction and reflection seismics, Georadar. Discussion of survey design, sources and receivers and data processing.


**Lecture notes**: Available through eDoz/ILIAS.

## Experimental Methods in Petrology (W 3 credits 2P C. Liesbcke)

**Objective**: Overview of the most common experimental methods employed in petrology to determine thermodynamic and physical properties and phase equilibria of minerals, mineral assemblages, magmas and fluids. The basic principals of low, moderate, high and ultrahigh pressure devices are discussed combined with an introduction into the synthesis of starting materials and the evaluation of run products.
Numerical Modelling in Fortran

This course gives an introduction to programming in FORTRAN95, and is suitable for students who have only minimal programming experience. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts.

Objective

- FORTRAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

Lecture notes

See http://jupiter.ethz.ch/~pj/FORTRAN/FortranClass.html

Numerical Modelling in Fortran (Project)

This course gives an introduction to programming in FORTRAN95, and is suitable for students who have only minimal programming experience. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts.

Objective

- FORTRAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

Content

- The project consists of writing a Fortran program to solve a problem agreed upon between the instructor and student; the topic is often related to (and helps to advance) the student’s Masters or PhD research. The project is typically started towards the end of the end of the main Fortran class when the student has acquired sufficient programming skills, and is due by the end of Semesterprüfung week.
The seminar series provides an opportunity to convey the latest research results to students and staff. After the course, students are able to understand and interpret measurements of ice flow, subglacial water pressure, and ice temperature. They have an understanding of glaciology-related physical concepts sufficient to understand most of the contemporary literature on the topic. The students will be well equipped to work on glacier-related problems by numerical modeling, remote sensing, and field work. The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and future evolution. We will take a closer look at ice deformation, basal motion, heat flow, and glacier hydraulic. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).

**Objective**

**Literature**
M. Lüthi: http://www.uzh.ch/studies/application/mobilitaet_en.html

**Prerequisites / notice**
Good high school mathematics and physics knowledge required.

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**Physics of Glaciers**

**Semester Paper in Paleontology (University of Zürich)**

**Seminar in Applied and Environmental Geophysics**

**Seminar in Hydrology**

**Seminar in Seismology**

**Research Seminar Structural Geology and Tectonics**

**Tunnelling**

**Colloquium Department Earth Sciences**

**Lecture notes**
See http://jupiter.ethz.ch/~pjt/FORTRAN/FortranProject.html

**Literature**
http://people.ee.ethz.ch/~luethim/teaching.html

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**Objective**
Understanding glaciers and ice sheets with simple physical concepts. Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, glacier seismology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.

After the course, the students are able to understand and interpret measurements of ice flow, subglacial water pressure, and ice temperature. They have a comprehensive understanding of glaciology-related physical concepts sufficient to understand most of the contemporary literature on the topic. The students will be well equipped to work on glacier-related problems by numerical modeling, remote sensing, and field work. The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and future evolution. We will take a closer look at ice deformation, basal motion, heat flow, and glacier hydraulic. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).

**Objective**
Short seminars on a variety of popular topics in Seismology. The seminars present current problems and research activities in the seismological community.

Understanding of a broad scope of current problems and state-of-the-art practice in seismology.

---

**Abstract**

- Face reinforcement
- Forepoling
- Drainage
- Ground freezing
- Jet grouting
- Injections

Auxiliary measures:
- Basic aspects of design and analysis of underground structures. Conventional tunnel construction methods. Auxiliary measures (ground improvement and drainage, forepoling, face reinforcement).
- Numerical analysis methods. Conventional excavation methods (full face, top heading and bench, side drift method, ...)
- Auxiliary measures:
  - Injections
  - Jet grouting
  - Ground freezing
  - Drainage
  - Forepoling
  - Face reinforcement

--

**Objective**
A seminar series with both invited speakers from both inside and outside the ETH. The seminar series provides an opportunity to convey the latest research results to students and staff. Informal seminars with both internal and external speakers on current topics in Structural Geology, Tectonics, and Rock Physics. The current program is available at: http://www.geology.ethz.ch/sgt/seminar/sgt_seminar.htm

---

**Content**

- Numerical analysis methods in tunnelling.
- Conventional excavation methods (full face, top heading and bench, side drift method, ...)
- Auxiliary measures:
  - Injections
  - Jet grouting
  - Ground freezing
  - Drainage
  - Forepoling
  - Face reinforcement

---

**Objective**
A seminar series with both invited speakers from both inside and outside the ETH.

The seminar series provides an opportunity to convey the latest research results to students and staff. Informal seminars with both internal and external speakers on current topics in Structural Geology, Tectonics, and Rock Physics. The current program is available at: http://www.geology.ethz.ch/sgt/seminar/sgt_seminar.htm

---

**Content**

- Unique ideas and analysis of underground structures. Conventional tunnel construction methods. Auxiliary measures (ground improvement and drainage, forepoling, face reinforcement).
- Numerical analysis methods. Conventional excavation methods (full face, top heading and bench, side drift method, ...)
- Auxiliary measures:
  - Injections
  - Jet grouting
  - Ground freezing
  - Drainage
  - Forepoling
  - Face reinforcement

---

**Content**

- Invited speakers from the entire range of Earth Sciences.

---

**Literature**

**Prerequisites / notice**

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**Objective**

**Literature**
M. Lüthi: http://www.uzh.ch/studies/application/mobilitaet_en.html

**Prerequisites / notice**
Good high school mathematics and physics knowledge required.

---

**Objective**

**Literature**
M. Lüthi: http://www.uzh.ch/studies/application/mobilitaet_en.html

**Prerequisites / notice**
Good high school mathematics and physics knowledge required.
### Objective
Selected themes in sedimentology, tectonics, paläontology, geophysics, mineralogy, paleoclimate and engineering geology on a regional and global scale.

### Content
According to variable program.

### Lecture notes
No

### Literature
No

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>CoR</th>
<th>University Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-2613-00L</td>
<td>Humangeography III (Geographies of Difference) (Universität Zürich)</td>
<td>5</td>
<td>W</td>
<td>1G+2S</td>
</tr>
<tr>
<td>651-2601-00L</td>
<td>Human Geography I: One Earth - Many Worlds (University of Zurich)</td>
<td>5</td>
<td>V</td>
<td>2V+2U</td>
</tr>
<tr>
<td>651-4088-03L</td>
<td>Physical Geography III (Geomorphology and Glaciology) (University of Zürich)</td>
<td>5</td>
<td>V</td>
<td>1V+1U</td>
</tr>
<tr>
<td>651-4088-01L</td>
<td>Physical Geography I (Fundamentals and Spheres) (University of Zürich)</td>
<td>5</td>
<td>V</td>
<td>2V+2U</td>
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<tr>
<td>651-1617-00L</td>
<td>Geophysical Fluid Dynamics and Numerical Modelling</td>
<td>0</td>
<td>E-Dr</td>
<td></td>
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<tr>
<td>651-4931-00L</td>
<td>Heat and Mass Transfers in Magmatology</td>
<td>1</td>
<td>W</td>
<td>1S</td>
</tr>
</tbody>
</table>

**Prerequisites / notice**
Besuch von GEO122.
Abstract
Heat and mass transfers in the crust control many aspects of the differentiation of our planet, including (1) type of volcanic eruptions we should expect at the surface of our planet, (2) the volcanic/plutonic ratio in the crust, and (3) how volcanic degassing occurs, with important consequences on the climate response following volcanic eruptions.

Objective
The goal of this class is to learn about the modern methods and ideas on heat and mass transfers in magmatology through recently published papers and computer software. The class will allow students to explore some of the most challenging concepts in this field, and become familiar with state-of-the-art techniques to model these processes.

Content
The class will focus mostly on reading recent literature on topics of interests, and will contain some computer exercises to allow students to work by themselves on some well-defined problems.

651-1091-02L
Geological Colloquium
E- Dr 0 credits 2K J.P. Burg, P. Nievergelt
Abstract
Invited speakers from the entire range of Earth Sciences.

Objective
Selected themes in sedimentology, tectonics, paläontology, geophysics, mineralogy, paleoclimate and engineering geology on a regional and global scale.

Content
The presentations are held in German. Membership of the Geological Society in Zurich is not required.

651-3280-00L
Earth Science Excursions
W 1 credit 2P P. Brack
Abstract
Only for MSc and doctrate students of D-ERDW. Only for excursions that are not part of the BSc excursion program 2.-6. semester.

Prerequisites
No

651-2001-00L
Semester Research Project
W 3 credits 6A Lecturers
Abstract
Small individual research project done by a student and supervised by a Professor/Dozent/Oberassistent of D-ERDW. The content of each project is unique and is defined by the supervisor. The project consists of research activity aimed at producing new scientific results and/or data.

Objective
- To learn logic, content and methodology of research aimed at producing new scientific results and/or data.
- To familiarize with research procedures in a selected scientific area.
- To get prepared for a MSc project.

Prerequisites
No

651-4060-00L
MSc Project Proposal
O 10 credits 21A S. Löw, Lecturers
Abstract
The MSc Project Proposal is only offered in autumn semester, a registration in spring semester is non-refundable.

Objective
The main purpose of the Master Project Proposal is to help students organize ideas, material and objectives for their Master Thesis, and to gain experience in writing a scientific proposal.

Prerequisites
a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme;
c. have successful completed the MSc Project Proposal.

651-4062-00L
Master’s Thesis
O 30 credits 64D Lecturers
Abstract
Only students who fulfill the following criteria are allowed to begin with their master thesis:

- to formulate a scientific question
- to present scientific approach to solve the problem
- to interpret, discuss and communicate scientific results in written form
- to gain experience in writing a scientific proposal

Prerequisites
- the student has completed the Master's Thesis Proposal.
- the student has registered for the Master's Thesis course.
- the student has received approval from the professor.

Grading criteria for the Semester project is similar to these for an MSc project according to the assessment criteria of the MSc Project Proposal.
## Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-3001-AAL</td>
<td>Dynamic Earth I and II Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>E-</td>
<td>11 credits</td>
<td>24R</td>
<td>E. Kissling, M. Schönbächler</td>
</tr>
<tr>
<td>651-3002-AAL</td>
<td>Fundamentals of Geophysics Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>E-</td>
<td>6 credits</td>
<td>13R</td>
<td>P. Tackley, T. Gery</td>
</tr>
<tr>
<td>651-3003-AAL</td>
<td>Fundamentals of Geology Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>E-</td>
<td>6 credits</td>
<td>13R</td>
<td>S. Bernasconi, J.P. Burg, C. A. Heinrich, S. Löw</td>
</tr>
<tr>
<td>651-3004-AAL</td>
<td>Fundamentals of Geochemistry Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>E-</td>
<td>6 credits</td>
<td>21R</td>
<td>T. Driesner, O. Bachmann</td>
</tr>
<tr>
<td>406-0243-AAL</td>
<td>Analysis I and II Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>E-</td>
<td>14 credits</td>
<td>30R</td>
<td>M. Akveld, C. Busch</td>
</tr>
<tr>
<td>406-0062-AAL</td>
<td>Physics I Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>E-</td>
<td>5 credits</td>
<td>11R</td>
<td>A. Vaterlaus</td>
</tr>
</tbody>
</table>

### Objective
- **Mathematical formulation of technical and scientific problems.**

### Content
- **Mathematical tools for the engineer.**
  - Basic mathematical knowledge for engineers.
  - Complex numbers.
  - Calculus for functions of one variable with applications.
  - Simple Mathematical models in engineering.

### Literature
- Textbooks in English:
- Textbooks in German:
  - M. Akveld, R. Sperb: Analysis I, vdf
  - M. Akveld, R. Sperb: Analysis II, vdf
  - L. Papula: Mathematik für Ingenieure und Naturwissenschaftler, Vieweg Verlag
  - L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag
**651-3521-AAL**  
**Tectonics**  
**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**  
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.  

**Abstract**  
Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth.  
Understanding principles of theoretical and experimental geothermics and fundamentals of mantle and lithosphere rheologies.  

**Objective**  
Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth.  
Understanding principles of theoretical and experimental geothermics and fundamentals of mantle and lithosphere rheologies.  

**Content**  

**Lecture notes**  
Detailed scriptum in digital form and additional learning modules (www.lead.ethz.ch) available on intranet.  

**Literature**  
see list in scriptum.  

**Prerequisites / notice**  
PPT-files of each lecture may be played back for rehearsal on www.lead.ethz.ch.

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**529-2001-AAL**  
**Chemistry I and II**  
**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**  
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.  

**Abstract**  
General Chemistry I and II: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium, kinetics, acids and bases, electrochemistry  

**Objective**  
Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.  

**Content**  
1. Stoichiometry  
2. Atoms and Elements (Quantenmechanical Model of the Atom)  
3. Chemical Bonding  
4. Thermodynamics  
5. Chemical Kinetics  
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)  
7. Electrochemistry  

**Lecture notes**  
Nivaldo J. Tro  
Chemistry - A molecular Approach (Pearson), Chapter 1-18  

**Literature**  
Housecroft and Constable, CHEMISTRY  
Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY  

**406-0603-AAL**  
**Stochastics (Probability and Statistics)**  
**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**  
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.  

**Abstract**  
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.  

**Objective**  
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".
Introduction to Engineering Geology

**Introduction**
This introductory course starts from a description of the behavior and phenomena of soils and rocks under near surface loading conditions and their key geotechnical properties. Lab and field methods for the characterization of soils, rocks and rock masses are introduced. Finally practical aspects of ground engineering, including tunneling and landslide hazards are presented.

**Objective**
- Understanding the basic geotechnical and geomechanical properties and processes of rocks and soils.
- Understanding the interaction of rock and soil masses with technical systems.
- Understanding the fundamentals of geological hazards.

**Content**
- Rock, soil and rock mass: scale effects and fundamental geotechnical properties.
- Soil mechanical properties and their determination.
- Rock mechanical properties and their determination.
- Fractures: geotechnical properties and their determination.
- Geotechnical classification of intact rock, soils and rock masses.
- Natural and induced stresses in rock and soil.
- Interaction of soil masses with surface loads, water and excavations. Slope instability mechanisms and stability analyses.
- Underground excavation instability mechanisms and rock deformation.
- Geological mass wasting processes.

**Lecture notes**
Written course documentation available under "Kursunterlagen".

**Literature**
### Educational Science (for all Directions)

#### Introduction

This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

#### Objective

- Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

#### Content

Thematical Schwerpunkte:

- Lernen als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wissenstransfer; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien, Geschlechtsunterschiede beim Lernen

Lernformen:


#### Literature


#### Prerequisites / notice

This lecture is only apt for students who intend to enrol in the programs "Lehrdiplom" or "Didaktisches Zertifikat". It is about learning in childhood and adolescence.

### Support and Diagnosis of Knowledge Acquisition Processes (EW3)

**Number:** 851-0238-01L

**Title:** Support and Diagnosis of Knowledge Acquisition Processes (EW3)

- Enrollment only possible with matriculation in Teaching Diploma (except for students of Sport Teaching Diploma, who complete the sport-specific course unit EW3) and for students who intend to enrol in the "Teaching Diploma".
- Prerequisites: successful participation in 851-0240-00L "Human Learning (EW1)"

**Abstract**

In this seminar students learn advanced techniques to support and to diagnose knowledge acquisition processes in school.

**Objective**

The main goals are:

1. You have a deep understanding about the cognitive mechanisms of knowledge acquisition.
2. You have a basic understanding about psychological test theory and can appropriately administer tests.
3. You know various techniques of formative assessment and can apply these to uncover students' misconceptions.

**Prerequisites / notice**

Für eine reibungslose Semesterplanung wird um persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

### Biological Direction

#### Specialised Courses

#### Introductory Courses

**Selection of courses will be agreed with the course coordinator.**

#### Spec. Courses in Respective Subject with Educational Focus

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0963-00L</td>
<td>Specialized Biology Course with an Educational Focus: Teaching Diploma</td>
<td>W</td>
<td>12</td>
<td>26A</td>
<td>E. Hafen, J. Egli, W.D. Hardt, M. Zwicky</td>
</tr>
</tbody>
</table>

**Abstract**

Specialist aspects of biology are covered from the angle of imparting these to pupils, their historical development, and their significance for the subject, the individual and society.

**Objective**

After successfully completing the module, students should be in a position:

- to call up more in-depth specialist knowledge of biology, covering a wide range of topics, and to impart this to others.
- to explain biological concepts and principles, as well as the way they fit together.
- to analyse controversial topics and to give factual explanations for these.
- to conduct more in-depth work on a research topic and to compile a tuition unit based on this topic
- to prepare tuition units involving complex learning matter at a high specialist level which are suitably tailored to the recipients, and to teach these in a manner conducive to learning.
Content
- Demanding biological topics are dealt with under consideration of the special needs of persons involved in teaching. The module comprises the parts:
  1) Lecture (Tues. 08.00-09.45 hrs)
  2) Colloquium (every second Tues. 10.15-12.00 hrs., begins on first lecture day)
  3) Seminar with presentation (every second Tues. 10.15-12.00 hrs., begins in second lecture week)
  4) Semester thesis in a research group (7 weeks)

Lecture notes
- Unterlagen für den Unterricht werden online mit Hilfe der e-learning Platform OLAT abgegeben.
- Specific references will be made available for the individual projects.

Literature
- Literatur und Literaturhinweise werden mit der e-learning Platform OLAT abgegeben.

Prerequisites / notice
- This Course lasts for two semesters. It can be started in autumn or in spring. Booking is only required once.

Performance Assessment:
- Performance is assessed during the course of the entire modul, with a final test. Active participation in the colloquia and group seminars is required. The thesis report and an oral presentation have to be completed.

The Specialized Biology Course with an Educational Focus (12 CP) can be acknowledged, in agreement with the advisor of the respective elective major, as one of the two obligatory research projects (each 15 CP). In such a case, additional 3 CP must be obtained in another course.

In case of overbooking of the course, students enrolled in the Teaching Diploma in Biology will have priority for registration.

The course is organized jointly with the University of Zurich (Fachbereich Biologie) and is held at the Life Science Zurich Learning Center of the ETH Zurich and the University of Zurich.

Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0963-02L</td>
<td>Specialized Biology Course with an Educational Focus II: Teaching Diploma</td>
<td>W</td>
<td>6</td>
<td>13A</td>
<td>E. Hafen, J. Egli, M. Zwicky</td>
</tr>
</tbody>
</table>

Abstract
- Specialized aspects of biology are dealt with under the viewpoint of their presentation, their historical development, their significance for the field, the individual and society.

Objective
- The goal is to promote the ability to understand biological concepts, principles and their interrelationships and to communicate specialist knowledge to various groups of recipients in an understandable manner.

Content
- Demanding biological topics are dealt with under consideration of the special needs of persons involved in teaching. The module:
  1) Lecture (Tues. 08.00-09.45 hrs)
  2) Colloquium (every second Tues. 10.15-12.00 hrs., begins on first lecture day)
  3) Seminar with presentation (every second Tues. 10.15-12.00 hrs., begins in second lecture week)
  4) Semester thesis in a research group (3.5 weeks)

Lecture notes
- None.

Literature
- Specific references will be made available for the individual projects.

Prerequisites / notice
- The program of this course represents one half (6 CP) of that of the Specialized Biology Course with an Educational Focus (551-0963-00, 12 CP).

Professional Exercises in Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0913-00L</td>
<td>Professional Exercises in Biology</td>
<td>W</td>
<td>2</td>
<td>2U</td>
<td>P. Faller</td>
</tr>
</tbody>
</table>

Abstract
- Students conduct a series of "classical" biological school experiments and therefore gain practice and experience in this area.

Objective
- Implementation of Subject Didactics I and II with the focus on conducting biological experiments in schools. This includes finding, testing and further developing suitable protocols for different subject areas of school biology. Working out how to didactically embed the experiments in lessons.
- Students can perform, off the cuff, 12 school experiments (which they have tested themselves), from the different subject areas, and conduct these correctly in technical terms. They can incorporate these experiments in their tuition in a didactically meaningful manner. Comments:
  - By contrast to the Subject Specialisation 1 and 2 course units, these are "basic tests" and do not involve the implementation of current research topics. The students' compilations are available in a data archive.
  - Hand out of course material.

Subject Didactics Biology I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0971-00L</td>
<td>Subject Didactics Biology I</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Faller</td>
</tr>
</tbody>
</table>

Abstract
- Basic conditions for tuition (MAR - recognition of Matura certificates - curricula, standards), selection of topics and reduction of the complexity of topics.
- Application of teaching methods and techniques from educational science in biology classes.
- Planning and preparation of lessons.

Objective
- Students can discuss and put into practice in their teaching work the conditions and objectives set out in the regulations governing the school-leaving examination (Matura), the framework curriculum and the conditions and objectives specified by their school.
- They are in a position to select learning objectives and formulate these on the basis of the target level model. They can plan and prepare lessons and can also develop appropriate learning assignments.
- Students can reconstruct specialist contents in didactic terms and develop teaching modules suitable for the different levels from these on the basis of the subject structure and learner requirements.
- They can reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners.
- They can select appropriate media for their work (e.g. school books) and use these. They can employ appropriate experiments.
- The students can use different forms of examination for monitoring performance.
- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.
**Chemical Direction**

**Specialised Courses**

**Introductory Courses**

**Spec. Courses in Respective Subject with Educational Focus**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0962-00L</td>
<td>Fundamental Aspects of Chemistry with an Educational Focus B</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>A. Togni, R. Alberto</td>
</tr>
</tbody>
</table>

**Abstract**

Selected topics in general chemistry:

1) The language of chemistry
2) Chirality and stereochemistry
3) Oxidation of water
4) Chemistry of the atmosphere

**Objective**

In this course, participants acquire extended and more in-depth knowledge of selected chemistry topics. The selection is based to a large extent on the partial aspects of chemistry that are typically taught at high school. By gaining a broader understanding, teachers are put in a position where they can comprehend the topics that are to be taught in a wider and, to some extent, unconventional context and critically assess pupils’ prior knowledge, clarify it in greater detail and take it into account for planning lessons.

**Content**

The selection of courses will be agreed with the course coordinator.

**Subject Didactics**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</tr>
</thead>
<tbody>
<tr>
<td>529-0950-00L</td>
<td>Subject Didactics Chemistry I</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Baertsch</td>
</tr>
</tbody>
</table>

**Abstract**

Implementing findings from research into teaching and learning for chemistry lessons and coverage of subject-specific teaching and learning specialties.

**Objective**

Among other things, students are put in a position where they can:

- divide up the subject matter into contents that can be learned by heart or accessed intellectually, and communicate these contents;
- break down technically complex contents to the right level for a class and still present these in a stringent, error-free manner in their simplified form;
- establish which subject matter can be presented with which teaching techniques and methods that have been recognised as efficient in teaching terms, and adapt these tools to the learning content in question;
- plan school experiments, incorporate them in lessons, perform them in accordance with all the rules of the art, and also evaluate them in a beneficial manner;
- assess pupils’ prior knowledge, clarify it in greater detail and take it into account for planning lessons;
- design a sequential curriculum suitable for the levels in question and put it into practice;
- reliably identify stumbling blocks in the contents and get round these.

**Content**

Schwerpunkte im ersten Studiensemester bilden die folgenden Themen:

- Auswahl gymnasiamsrelevanter Lerninhalte
- Modellbegriff in den Naturwissenschaften, insbesondere der Chemie
- Sprache und Fachsprache im Chemieunterricht
- Wechselwirkung zwischen Beobachtungen in der realen Welt und Deutungsversuchen auf der Modell-Ebene
- Interdisziplinarität mit Biologie, Mathematik und Physik
- Lehrerstil und -beurteilung im Theorie- und Laborterritor
- Atommöglichkeiten und chemische Bindung
- Matheamatisch Beschreibung chemischer Systeme (z.B. Stöchiometrie und Gleichgewichtsyssysteme)
- Auswahl, Konzeption, Einbettung, Vorbereitung, Durchführung, Nachbereitung und Auswertung von Demonstrations- und Schüler-Experimenten

**Notice**

(please the Buch in der Auflage von 2011 vor dem ersten Treffen erwerben!)
Der Chemieunterricht am Gymnasium soll einerseits dem zukünftigen Nichtnaturwissenschaftler ein grundlegendes Rüstzeug an chemischen Kenntnissen und Fähigkeiten für den Alltag an die Hand geben, andererseits aber auch auf ein naturwissenschaftlich orientiertes Hochschulstudium vorbereiten können. Diese beiden Anforderungen sind im Unterricht gleichermaßen zu berücksichtigen.

Da viele Lerninhalte zudem zwingend sequentiell und einander benützend strukturiert sind, ist dem logischen und aus Schülerperspektive nachvollziehbaren Aufbau des Unterrichts besonderes Augenmerk zu schenken. Dies bedeutet eine besonders feine Abstimmung von fachlichen Inhalten unterschiedlichen Niveaus und der für ihre Vermittlung eingesetzten didaktischen Methoden und Techniken auf die kognitive Leistungsfähigkeit der Lernenden.

Anhand der Diskussion ausgearbeiteter und bewährter Beispiele, aber auch durch selbständiges Probeprobieren und mit Hilfe selbst zu erstellender kleiner Unterrichtsbausteine soll die zukünftige Lehrkraft befähigt werden, einen den spezifischen Rahmenbedingungen angepassten eigenen Unterricht zu konzipieren und durchzuführen, der diesem hohen Qualitätsanspruch genügen kann.

### 402-0091-00L Teaching science in Higher Education

<table>
<thead>
<tr>
<th>W</th>
<th>2 credits</th>
<th>1V</th>
<th>G. Schiltz</th>
</tr>
</thead>
</table>

**Abstract**

This course imparts fundamental didactic concepts that are relevant to teaching science in a Higher Education context.

**Objective**

Students are able to characterize and to discuss the model of outcomes based education.

Students are able to transfer the basic concepts of this model (ILO, TLA, assessment, constructive alignment) to science education.

**Lecture notes**

keines

**Literature**


(please get the book in the fall of 2011 before the first meeting.)

## Physical Direction

### Specialised Courses

#### Introductory Courses

#### Spec. Courses in Respective Subject with Educational Focus

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0737-00L</td>
<td>Energy and Environment in the 21st Century (Part I)</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>M. Dittmar</td>
</tr>
</tbody>
</table>

**Abstract**

The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

**Objective**

Scientists and espially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.

The lecture is for students which are interested participate in a rational and responsible debate about the energyproblem of the 21. century.

**Content**

Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human needs/uses?

Energy conservation and the first and second law of thermodynamics

Fossil fuels (our stored energy resources) and their use.

Burning fossil fuels and the physics of the greenhouse effect.

physics basics of nuclear fission and fusion energy

controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.

Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.

The problems with nuclear fusion and the ITER project.

Nuclear fusion and fission: “exotic” ideas.

Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.

new clean renewable energy sources and their physical limits (wind, solar, geothermal etc)

Energy perspectives for the next 100 years and some final remarks

http://ip-p-lx2.ethz.ch/energy21/

**Literature**

Die Energiefrage - Bedarf und Potentiale, Nutzung, Risiken und Kosten:


Environmental Physics: Boeker and Egbert New York Wiley 1999

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 604 of 1571
Science promised us truth, or at least a knowledge of such relations as our intelligence can seize: it never promised us peace or happiness.

Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question. Rather, it's whether or not the theory gives predictions that agree with experiment.

Richard Feynman, 1985

Science in School (Current Topics for the Classroom) W 2 credits 2G C. Wagner, A. Vaterlaus

Enrolment in Physics Didactics I (402-0910-00L) and Physics Didactics II (402-0910-00L) is mandatory.

Kennenlernen und erarbeiten (Übungen) von Unterrichtssequenzen zu modernen Themen der Physik.


Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0910-00L</td>
<td>Physics Didactics I: Special Didactics of Physics Teaching</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Mohr</td>
</tr>
</tbody>
</table>

Limited number of participants.

Further information is available from the lecturer via email: mamohr@ethz.ch

Simultaneous enrolment in Introductory Internship Physics - course 402-0920-00L - is compulsory for Teaching Diploma Physic

Information for UZH students:
Enrolment to this course unit only possible at ETH. No enrolment to module 090Phy1 at UZH.
Please mind the ETH enrolment deadlines for UZH students: https://www.ethz.ch/en/studies/non-degree-courses/special-students/special-students-university-of-zurich.html

Abstract
This course imparts fundamental didactic concepts that are relevant to teaching science in a Higher Education context.

Objective
Students are able to characterize and to discuss the model of outcomes based education.

Students are able to transfer the basic concepts of this model (ILO, TLA, assessment, constructive alignment) to science education.

Science Education Master - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Eligible for credits and recommended</th>
<th>Eligible for credits</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>Z</td>
<td>Suitable for doctorate</td>
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<tr>
<td>W</td>
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<tr>
<td>E-</td>
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</table>
### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
Military Studies

Military History I (without Exercises)

- Objectives:
  - Distinguish between military history as a subject and historiography as a way of describing events;
  - Analyse the modern developments regarding armed forces and warfare in the context of socio-economic changes;
  - Based on the approach regarding revolution in military affairs, describe the evolution of the armed forces and of warfare;
  - Exemplify the issues regarding the evolution of the combat (First and Second World War, Vietnam War and Algerian War).

- Content:
The lecture first examines the bases of the science of (military) history. It focuses on how military history developed from war history, on specific similarities and differences between military history and general historiography, the different ways of dealing with history in Switzerland, Germany, France and in the Anglo-Saxon cultural area (different approaches) as well as on institutions which deal with military history such as universities, military academies, national and international commissions and associations etc.

- Literature:

Military Business Administration II - Case Examples

- Objectives:
  - Students who are intrinsically interested in business-related issues will be provided with a big picture that transcends the micro view of business administration. Students learn how to integrate security and resource-related issues into a global economic analysis and how to derive relevant consequences, particularly economic ones, for Switzerland.
The program of the course is organized into 14 units of 90 minutes each. The units combine the elements of lecture (where analytical concepts are taught) and application (where these concepts are applied). Additionally, guest lecturers will hold talks on selected issues.

* Swiss economic autarchy - madness or option?
* Global resource positions and world trade: Implications for the Swiss Armed Forces I
* Global resource positions and world trade: Implications for the Swiss Armed Forces II
* Economic causes of military instability
* Aggressive emerging economies: Economic growth and rearmament
* The process of an arms deal
* Costs and financing of a military conflict
* Economic analysis of terrorism
* Economic analysis of cyberwar
* Economic analysis of the present GSOA initiative: Compulsory military service vs. voluntary militia
* Global arms production and international arms trade
* The privatisation of military security
* Standardisation and interoperability: Does NATO membership increase Swiss military efficiency
* Written exam

Lecture notes
As this course has been completely redesigned and is being offered for the first time in the fall semester of 2013, a script is not yet available. However, the lecturer will distribute all necessary course material in time and directly to the students, either in the classroom or by uploading files to a public server.

Literature
The Lecturer will distribute all necessary literature directly to the students by disseminating pdf files or citing links to online references.

Prerequisites / notice
Exam “Military Business Administration I” passed successfully or profound basic knowledge of business administration and economics. The course is open to external participants.

853-0064-00L  Military Sociology I
Z  3 credits  2V  T. Szvircsev Tresch

Abstract
Beside of the most important terms of sociology, demographic changes and the related value and structure change will be analysed. The second part focuses on organizational sociology. Thirdly, the course examines to which extent armed forces can be considered as organizations like any other and to which extent they constitute a special case from an organizational and normative point of view.

Objective
Recognize and explain current changes (social change) in modern society (individualisation, pluralisation); describe demographic changes in Switzerland; explain the structures of societies; define issues and fields of research in modern military sociology and explain the foundations of organisational sociology; explain the military in terms of organisational sociology and identify specific traits of the military as an organisation.

Content
Societal change; organizations as societal phenomena; aims, structures, environments of organizations; specifics of the military as an organization; impacts of technological and societal changes on the armed forces in modern societies.

Literature
A reader with a set of texts will be handed out.

Specialized Continuing Education

Special internal ETH courses offered by LET and the Teaching Specialists.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>999-9999-99L</td>
<td>EduApp Course</td>
<td>E-</td>
<td>0 credits</td>
<td>1V+1U</td>
<td>G. Schiltz</td>
</tr>
</tbody>
</table>

This course unit is not a genuine ETH course unit. It is used by LET and the Teaching Specialists for EduApp demonstration purposes.

Humanities, Social and Political Sciences (General Courses) - Key for Type

| O      | Compulsory                      | E-   | Recommended, not eligible for credits |
| W+     | Eligible for credits and recommended | Z    | Courses outside the curriculum      |
| W      | Eligible for credits            | Dr   | Suitable for doctorate              |

Key for Hours

| V      | lecture                        | P    | practical/laboratory course        |
| G      | lecture with exercise          | A    | independent project                |
| U      | exercise                       | D    | diploma thesis                    |
| S      | seminar                        | R    | revision course / private study    |
| K      | colloquium                     |      |                                     |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
H. Fischer-Tiné

### History

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0549-00L</td>
<td>WebClass Introductory Course History of Technology</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>G. Hürlimann</td>
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<tr>
<td></td>
<td>Number of participants limited to 100.</td>
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<td>Particularly suitable for students of D-BAUG, D-INFK, D-INFK, D-ITET, D-MATL, D-MAVT.</td>
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<tr>
<td></td>
<td>Abstract WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.</td>
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<td>Objective Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get to know basic theories and practices of the field.</td>
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<td></td>
<td>The Zahl der Teilnehmenden ist auf 100 beschränkt. Anmeldung: In der Einführungssitzung am 26.9.2016, zudem schriftliche Verspätete Anmeldungen können nicht berücksichtigt werden.</td>
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<td>Weitere Informationen unter <a href="https://www.tg.ethz.ch/de/programme/">https://www.tg.ethz.ch/de/programme/</a></td>
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<tr>
<td>853-0725-00L</td>
<td>History Part One: Europe (The Cradle of Modernity, Britain ca. 1789-1939)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>H. Fischer-Tiné</td>
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<tr>
<td></td>
<td>Abstract Using the concrete example of Britain, the &quot;cradle of modernity&quot;, this lecture offers a survey and analysis of the crucial historical transformations that engendered &quot;modernity&quot; in Europe from the late 18th to the mid 20th centuries.</td>
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<td>Objective At the end of this lecture course, students can: (a) highlight the most important changes in the &quot;long nineteenth century&quot; in Europe (b) explain their long-term effects; and (c) relate these changes to global developments.</td>
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<td>Content The thematic foci include: the economic and social consequences of the industrial revolution, the genesis of political ideologies and social movements, shifts in gender roles, colonialism and imperialism, as well as the emergence of consumerism and a &quot;leisure society.&quot;</td>
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<td></td>
<td>Lecture notes Power Point Slides and sources will be made available at POLYBOX in the course of the semester.</td>
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<td>Literature Mandatory and further reading will be listed on course plan that is made available before the first session.</td>
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<tr>
<td>851-0551-03L</td>
<td>Postal Knowledge and the History of Digital Societies</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>D. F. Zetti</td>
</tr>
<tr>
<td></td>
<td>Abstract In the second half of the 20th century, postal services have dramatically changed. Communication today is computer-based. The lecture offers problem oriented insights into this sociotechnical process of translation.</td>
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<td>Objective Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication.</td>
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<tr>
<td></td>
<td>Literature</td>
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<tr>
<td>851-0101-18L</td>
<td>&quot;Bollywood and Beyond&quot; - A Cultural History of Indian Cinema in the 20th Century</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>H. Fischer-Tiné</td>
</tr>
<tr>
<td></td>
<td>Abstract The Indian film industry has been around for 100 years and is one of the richest and most variegated of the world. The lecture reconstructs the historical development of Indian cinema and uses it as a lens through which cultural, social and political change in the subcontinent can be explored.</td>
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<td>Objective The objectives of this course are three-fold. For one, the participants shall learn to question aesthetic cetainties and received modes of perception of cinematographic art. Secondly they will be acquainted with the huge potential of films as a historical source to grasp processes of social and cultural change. Besides, the reconstruction of the international career of a specific variety of art and entertainment will also raise important questions of cultural globalisation and consumerism. As a side-effect, a sit were, the students will will also be provided with important insights into the chequered history of the Indian subcontinent in during the course of the 20th century.</td>
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<td></td>
<td>Prerequisites / notice A detailed course description and session plan will be available from 15 Sept 2013 onwards at <a href="http://www.gmw.ethz.ch/education">http://www.gmw.ethz.ch/education</a></td>
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</tbody>
</table>
The aim of this seminar is threefold: Firstly, students will become familiarised with historiographical approaches to scientific collections. Among them are constructivist approaches that seek to understand scientific knowledge not primarily as a system of objective truths, but rather as an outcome of human 'constructions'. Other approaches deal with the problem of how scientific objects are related to systems of power and oppression, namely in the case of objects collected during the time of European colonialism overseas. Secondly, students will become familiarized with how old collections can yield new insights for current scientists working, e.g., on questions of ecology. Thirdly, the seminar shall serve as a platform to discuss ways of dialogue and possible collaboration between these different approaches.

Students will be expected to read theoretical texts and case studies during semester, participate in discussions with external experts (historians, curators, and scientists), and to write a summarizing essay at the end of the term.

The course explores the complex nature of politics and history of the Arabian Peninsula. It takes a closer look at the political systems of several countries of the Arabian Peninsula, especially Yemen, Saudi Arabia and Oman and Bahrain.

To highlight how the politics of the Arabian Peninsula is a product of two spheres: politics within states and politics between states. An overview of the type of political systems prevalent in the region, religious Denominations, sectarian rivalry, and how these shape its regional relations.

The two-semester course offers an introduction to the history and theory of architecture from the industrial revolution up to now. Based on current questions a variety of case studies will be discussed.

The subject of this lecture course is the history and theory of architecture since the beginning of the 19th century up to now. It examines the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.

851-0512-05L Development Cooperation from a Biographical Point of View  
W 3 credits 2U  G. Spuhler

Abstract
The Archives of Contemporary History provide 75 video interviews with contemporary witnesses who report on their missions abroad for Swiss humanitarian aid and development cooperation. Based on selected interviews the motives of their commitment and the experience in a foreign country are examined.

Objective
The course provides basic knowledge about the beginnings of modern development aid and its increasing professionalism. It aims for a critical and historically informed reflection on the transfer of knowledge and technology between the first and the third world. Furthermore it sharpens the critical awareness of the possibilities and limitations of retrospective accounts of eyewitnesses.

Literature

851-0101-53L Collections in Context: What Do Historians and Scientists Learn from Butterflies, Stones, and Bones?  
Particularly suitable for students of D-BIOL, D-BSSE, D-USYS
W 3 credits 2S  B. Schär, M. Greeff

Abstract
Zurich holds huge scientific collections. They contain objects from around the world, some of them dating back to the 18th century. This interdisciplinary seminar combines perspectives from the history of science and from current scientific disciplines. What do these objects tell us about Zurich's place in the global history of science? What potentials do old collections hold for scientists today?

Objective
The aim of this seminar is threefold: Firstly, students will become familiarized with historiographical approaches to scientific collections. Among them are constructivist approaches that seek to understand scientific knowledge not primarily as a system of objective truths, but rather as an outcome of human 'constructions'. Other approaches deal with the problem of how scientific objects are related to systems of power and oppression, namely in the case of objects collected during the time of European colonialism overseas. Secondly, students will become familiarized with how old collections can yield new insights for current scientists working, e.g., on questions of ecology. Thirdly, the seminar shall serve as a platform to discuss ways of dialogue and possible collaboration between these different approaches.

Students will be expected to read theoretical texts and case studies during semester, participate in discussions with external experts (historians, curators, and scientists), and to write a summarizing essay at the end of the term.

851-0535-09L Regional Politics of the Arabian Peninsula  
W 2 credits 2K  E. Manea

Abstract
The course explores the complex nature of politics and history of the Arabian Peninsula. It takes a closer look at the political systems of several countries of the Arabian Peninsula, especially Yemen, Saudi Arabia and Oman and Bahrain.

Objective
To highlight how the politics of the Arabian Peninsula is a product of two spheres: politics within states and politics between states. An overview of the type of political systems prevalent in the region, religious Denominations, sectarian rivalry, and how these shape its regional relations.

Content
The neighbouring states of the Arabian Peninsula - especially Saudi Arabia, Oman and Yemen - make for strange bedfellows. They are governed by different systems with different results, calling into question how their internal policies affect regional relations and vice versa. Saudi Arabia is a monarchy, a prosperous, religious and restrictive state increasingly facing problems of social/political unrest. Oman is a small, thriving, stable sultanate, modernized and moderate but tightly controlled; and the republic of Yemen, which has the region's poorest economy, has still not shrugged off the legacy of its turbulent modern history. Each state adheres to a different Islamic sect, moreover, and though their populations are overwhelmingly Arab, differing tribal structures result in widely variant effects on the political process in their respective systems. Each state has also had extensive historical relationships with the Ottoman and British empires, the US and Russia, and these too have coloured regional relations. Recent events like the terrorist attacks of 11 September 2001, the American-led invasion of Iraq and the Arab Spring of 2011 have also influenced these states’ internal policy decisions, further affecting their dealings with one another and at with the world at large. This course examines each country in detail, from state formation to current affairs and from local to international government.

051-0311-00L History of Art and Architecture III  
W 3 credits 2V  L. Stalder

Abstract
The two-semester course offers an introduction to the history and theory of architecture from the industrial revolution up to now. Based on current questions a variety of case studies will be discussed.

Objective
The aim is to give an overview on crucial events, works of art, buildings and theories since the beginning of the 19th century up to today. The course should enhance the comprehension of historical and theoretical issues, and allow the students to localize their own practice within a broader historical context.

Content
The subject of this lecture course is the history and theory of architecture since the beginning of the 19th century up to now. It examines the architectural answers to the changing technical inventions and social practices. Consequently, the focus will be less on individual architects or buildings than on various themes that determined the architecture of the period.

Lecture notes
http://www.stalder.arch.ethz.ch/courses

051-0363-00L History of Urban Design I  
W 2 credits 2G  V. Magnago Lampugnani

Abstract
The lecture covers the time from the beginning of urban culture until the mid 19th century. With selected examples it emphasizes on the historical plannings and methods of European cities. Each specific urban development will be presented within a broader context.

Objective
This course analyzes the history of urban architecture primarily in its existing three dimensional form as a complex human artefact. It also explores the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.
In the first semester an introduction to the discipline and the methods are given along the thematic issues from the beginning of urban culture until the mid-19th century.

01. Introduction to the discipline and method: The history of urban design as a historical project

02. Athens and Rome in the ancient world: Myth, self-portrayal and speculation

03. From the spirit of equality to the colonial module: Greek and Roman City foundings

04. From the urban ideal to new cities in the Middle Ages and the Renaissance

05. Baroque strategies: The new organisation of Rome under Sixtus V, the production of Versailles under Louis XIV and the invention of St. Petersburg

06. The city between Absolutism and Enlightenment: baroque defence-designs, the European colonization of the American continent and the reconstruction of Lisbon

07. Ideology and speculation after the Glorious Revolution: landscape gardens and urban figurations in England from 1650-1850

08. Between modernization, Grandeur and repression: Embellishment in Paris from 1750-1830

09. The construction of the bourgeois city: Georges-Eugène Haussmann transforms Paris into the capital of the 19th century

10. Architectural insertion and plan for the expansion of the city: From the Berlin of Karl Friedrich Schinkel to James Hobrecht

11. Neoabsolute power, bourgeois self-confidence and Marxian Idealism: The Viennese Ringstrasse and Ildefonso Cerdas Ensanche for Barcelona

The lectures are accompanied by a script (two semesters of the bachelor studies), that can be purchased at the chair for the history of Environmental History - Introduction and Overview 2 credits 2V

Further recommended literature to consult is listed within the script.

Number of participants limited to 100.


Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.

Students are asked to write an exam during the second last session (11.12.2015).

The lecture which will be held only in one semester includes the developments of the 20th century

1. Le Corbusier: theories, visions and clear cuts in the name oft he autorité

2. The United States in the Jazz Age: Between Metropolis of Tomorrow and Broadacre City

3. Italy in the Fascist Era: Monumental ensembles and new town between assiduousness of modernization and obsession of representation

4. Urban design under totalitarian regimes: The architects of the "Tausendjährige Reich" and the "engineers of luck" of the Soviet Union of Stalin

5. Coming to terms with the past and the Cold War: Reconstruction in the two German states

6. The myth of the human scale: the 1950s in Spain, Great Britain, Scandinavia and Italy

7. Postwar Experiments: Rationalistic classicism in France

8. Two new towns in the 20th century: Chandigarh and Brasilia

9. Fictions and visions: the international utopia of the city

10. The second conquest of the North American territorium: The automobile and the city in the USA

11. Analysis, analogy and renewal: The adventure of the typological city
Further recommended literature to consult is listed within the script.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0300-85L</td>
<td>The Knowledge of Literature. An Introduction</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>A. Kilcher</td>
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<tr>
<td>Abstract</td>
<td>This seminar deals with the meaning and history of &quot;Witz&quot; (wit, joke) as a form of knowledge. It places &quot;Witz&quot; as a switch or transitional figure within the development of modern theories of knowledge in particular.</td>
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<td>Objective</td>
<td>Students are familiar with different relations between literature and technology. They can verbalise and analyse central contents.</td>
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<td>Abstract</td>
<td>The course discusses writers from Henry James to Margaret Atwood whose interest for photography led them to elaborate new intriguing modes of representation. The aim is to identify how literature, photography and art meet to promote a photographic aesthetics while approaching the theories of Susan Sontag, Roland Barthes and Bourdieu as well as postmodern or posthuman criticism.</td>
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<tr>
<td>851-0301-05L</td>
<td>Beginnings</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>C. Jany</td>
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<tr>
<td>Abstract</td>
<td>“All beginnings are difficult,” goes the saying, “but without them there wouldn’t be an end.” However, what makes beginnings so difficult? What kind of action is that? Which knowledge does it presuppose? And what would a beginning say about the end? We will pursue these questions by reading sacred, philosophical, literary, and scientific texts that, each in its own way, make a beginning.</td>
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<tr>
<td>851-0306-05L</td>
<td>Literature Technology - Simulations, Prototypes, Works of Machines Particularly suitable for students of D-ITET, D-MAVT, D-MATL</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>E. Edelmann-Ohler</td>
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<tr>
<td>Abstract</td>
<td>Literature about technology transposes models, products and procedures of scientific progress into the logic of poetry. This literature does not only technology into fiction, but it also creates new cultural and social contextualisations, which reveal alternative readings of configurations of knowledge.</td>
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<td>851-0309-15L</td>
<td>Thomas Mann’s Last Novel: “Bekenntnisse des Hochstaplers Felix Krull”</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>not available</td>
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<tr>
<td>Abstract</td>
<td>“Bekenntnisse des Hochstaplers Felix Krull” was published in 1954, one year before Thomas Mann’s death. This humorous autobiography is considered one of Mann’s most celebrated works.</td>
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<td>851-0300-79L</td>
<td>Theories of Joke</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>A. Kilcher</td>
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<tr>
<td>Abstract</td>
<td>From Plato, Aristotle and Cicero, philosophers have tried to find the core principle of wit (or the joke, as both meanings are contained in the German term &quot;Witz&quot;). Even during the 20th century, the philosophy of life and psychoanalysis struggle with it. The seminar provides an overview of this history.</td>
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<td>Content</td>
<td>Contrary to intuitive expectations, the German term &quot;Witz&quot; is not only an instance of the comical, but also a form of knowledge that plays on similarity and difference by juxtaposing the disparate. In this vein, especially during the 17th and 18th centuries, &quot;Witz&quot; becomes a central attribute of poetic and rhetorical forms of expression (wit). Only during the 19th century &quot;Witz&quot; comes to denote a characteristic genre of the comical (joke). From now on &quot;Witz&quot; is theoretically associated with the comical and laughter. Around 1800 there are approaches based on the philosophy of life, sociology and psychology, elaborated by Bergson, Bakhtin and Freud, among others.</td>
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This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their research ideas in relation to behavioral science. The colloquium also features invited research talks.

We will look at a number of essays and texts on that subject. We will also read Zadie Smith's highly entertaining novel "White Teeth" which has a very elaborate not to say artificial plot. One line of the story is about the geneticist Marcus Chalfen and the "Future Mouse" he designed.

Recommended Reading: Zadie Smith: White Teeth; Emile Zola: The Experimental Novel

851-0129-00L  Writing for Others - Science and Public  W  2 credits  2V  U. J. Wenzel

Abstract
"Plot is to the novelist what experiment is to the scientist." (Lionel Trilling) We will read Emile Zola's essay "The Experimental Novel" and other texts to look on the one hand at the scientific aspect to fiction and fiction writing and on the other hand at the narrative and fictional aspects to science.

Objective
Compare and find out about differences and similarities between natural sciences and fiction/ fiction writing. Maybe become aware that "to conclude that what happens in the laboratory is what happens in the universe requires a leap of the imagination." (Trilling)

Content
We will look at a number of essays and texts on that subject. We will also read Zadie Smith's highly entertaining novel "White Teeth" which has a very elaborate not to say artificial plot. One line of the story is about the geneticist Marcus Chalfen and the "Future Mouse" he designed.

Recommended Reading: Zadie Smith: White Teeth; Emile Zola: The Experimental Novel

851-0315-01L  Writing: Precision of Language as a Field of Research for Literature  W  1 credit  1G  F. Kretzen

Abstract
When we write a literary text we enter into a set-up for experiments and explore the possibilities ensuing from the specific structure and consistency of such a text. Literary writing allows us to go over to another kind of knowledge. Thus, the question: what is it that I want to write about? is replaced by: what do I write?

Objective
In this course we shall analyze and apply conditions and criteria for literary writing on the basis of our own texts. The course is intended for persons who are interested in literary approaches to exactitude. Any attempt to write literature is confronted with an unforeseeable linguistic dynamism whose feasibility is determined by laws and rules quite different from those of science and technology. For the science-oriented writer, experiencing the self-evidence produced by literary approaches in his or her own writing project opens up a field of language with new content and new methods.

Content
When we write a literary text we enter into a set-up for experiments and explore the possibilities ensuing from the specific structure and overall consistency of such a text. This form of writing takes us from the question: what is it that I want to write about? to the question: what do I write?

How do such literary approaches differ from the ways in which the natural sciences use language?

In this course we shall analyze and apply conditions and criteria for literary writing on the basis of our own texts. The course is intended for persons who are interested in literary approaches to exactitude. Any attempt to write literature is confronted with an unforeseeable linguistic dynamism whose feasibility is determined by laws and rules quite different from those of science and technology. For the science-oriented writer, experiencing the self-evidence produced by literary approaches in his or her own writing project opens up a field of language with new content and new methods.

Prerequisites / notice
Those wishing to participate are required to send in between two and three pages text of their own writing that will be discussed in class.

The next step will be writing a text on a preset topic as a basis for discussing the various realizations of a given task.

851-0331-05L  The Art of Conversation  W  3 credits  2V  C. Thomas

Abstract
This course will offer the occasion to reflect upon the art of conversation: its codes, its pleasures of improvisation, its worldly aspects and its importance in everyday life.

Objective
This will permit us to consider different figures of the writer and salon hostess, such as Mme de Lafayette, Mme du Deffand, Julie de Lespinasse, and Mme de Staël.

851-0331-06L  The Secretaries of the Baroque Age and the "Honest Dissimulation"  W  3 credits  2V  S. Nigro

Abstract
Torquato Accento, secretary and poet, published the treatise "Della simulazione onesta" in 1641. It was a thin manual to survive political turmoils and moral instability of the time; it was also a guide to "secret" writing in a time of censorship. The course follows the reception of the treatise up to the 20th century and focuses on how it got shaped to meet various historical and political ideas.

Objective
The students know the author and his coeval context; the students can relate the writing modalities of the treatise to the socio-cultural context of various historical times; the students know how to identify and interpret the metaphorical potential of the texts, as well as its literary power.

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Economics

Number  Title  Type  ECTS  Hours  Lecturers

Abstract
This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their research ideas in relation to behavioral science. The colloquium also features invited research talks.

Objective
Students know and can apply autonomously up-to-date investigation methods and techniques in the behavioral sciences. They achieve the ability to develop their own ideas in the field and to communicate their ideas in oral presentations and in written papers. The credits will be obtained by a written report of approximately 10 pages.
Content
This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their ideas in so far as they have some relation to behavioral science. The possible research areas are wide and may include theoretical as well as empirical approaches in Social Psychology and Research on Higher Education. Sociology, Modeling and Simulation in Sociology, Decision Theory and Behavioral Game Theory, Economics, Research on Learning and Instruction, Cognitive Psychology and Cognitive Science. Ideally the students (from Bachelor, Master, Ph.D. and Post-Doc programs) have started to start work on their thesis or on any other term paper.

Course credit can be obtained either based on a talk in the colloquium plus a written essay, or by writing an essay about a topic related to one of the other talks in the course. Students interested in giving a talk should contact the course organizers (Rütsche, Stern) before the first session of the semester. Priority will be given to advanced / doctoral students for oral presentations. The course credits will be obtained by a written report of approximately 10 pages. The colloquium also serves as a venue for invited talks by researchers from other universities and institutions related to behavioral and social sciences.

851-0626-01L International Aid and Development W 2 credits 2V I. Günther

Abstract
Prerequisites: Basic knowledge of economics
The course gives economic and empirical foundations for a sound understanding of the instruments, prospects and limitations of international development aid.

Objective
Students have a theoretically and empirically sound understanding of the prospects and limitations of international development aid.

Content
Students are able to critically discuss the various aid instruments of bi-and multilateral donors and NGOs.

Literature
Articles and book abstracts will be uploaded to a course website.

851-0609-06L Governing the Energy Transition W 2 credits 2V T. Schmidt

Abstract
This course addresses the role of policy and its underlying politics in the transformation of the energy sector. It covers historical, socio-economic, and political perspectives and applies various theoretical concepts to specific aspects of governing the energy transition.

Objective
- To gain an overview of the history of the transition of large energy systems
- To recognize current challenges in the energy system to understand the theoretical frameworks and concepts for studying transitions
- To demonstrate knowledge on the role of policy and politics in energy transitions

Content
Climate change, access to energy and other societal challenges are directly linked to the way we use and create energy. Both the recent United Nations Paris climate change agreement and the UN Sustainable Development Goals make a fast and extensive transition of the energy system necessary.

Literature
Slides and reading material will be made available via moodle.ethz.ch (only for registered students).

851-0757-00L Environmental Management W 2 credits 2G R. Züst

Abstract
An environmental management system has the objective to continuously improve the environmental performance of the activities, products and services of a company. The company has to introduce different management procedures. The goal of this lecture is to provide basics and specific procedure to implement the environmental dimension in the planning and decision making processes of an organisation.

Objective
Overview on environmental management and environmental management systems, general methods and principles.

Content
Introduction to environmental management / environmental management systems, energy and material flows; economical and ecological problems in industry; characterisation of an enterprise (incl. management handbook); structure and contents of an environmental management system; overview on the ISO 14001 ff. series; methods for environmental evaluation and assessment; integrated management systems; planning methodology and life-cycle-design design; planning example

Lecture notes
Information about environmental management and environmental management systems will be provided by a CD or mail.

Literature
A list with literatures and links will be provided.

Prerequisites / notice
Delivery of a case study, worked out in groups. Language: Teaching in English on request.


Abstract
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.

Objective
Students
- have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software STATA for data Analysis
Introduction to Health Economics and Policy

**W 3 credits 2G W. Mimra**

**Abstract**
Health expenditures constitute about 10% of GDP in OECD countries. Extensive government intervention is a typical feature in health markets. Risk factors to health have been changing with growing importance of lifestyle factors such as smoking, obesity and lack of physical activity. This course gives an introduction to the economic concepts and empirical findings in health economics.

**Objective**
Introduce students without prior economics background to the main concepts of health economics and policy to enhance students understanding of how health care institutions and markets function.

**Content**
The course gives an introduction to the economic concepts and empirical findings in health economics to enhance students understanding of how health care institutions and markets function. First, the three important decisions made by individuals will be analyzed: What determines the health behaviors, like the intensity of preventive measures like sport, that an individual undertakes? What types and amount of personal health care services does an individual demand? How much health insurance coverage will be purchased?

In a second part, the major participants on the supply side of health care markets - physicians, hospitals, nurses and pharmaceutical manufacturers - will be discussed. E.g., how important are financial incentives in the choice of medicine as a career, specialty choice and practice location? What does it mean and imply that a physician is an agent for a patient? How do pharmaceutical firms decide on investments in new products and how can public policy encourage pharmaceutical innovation?

The choices made by societies about how health care services are financed and about the types of organizations that supply health care will be addressed in a third part. One important choice is whether a country will rely on public financing of personal health care services or encourage private health insurance markets. How could and should a public health insurance system be designed? What health care provision of public health care services, private provision by not-for-profit or for-profit organizations or some combination. The advantages and disadvantages of the alternatives will be discussed to provide a framework for analyzing specific types of health care systems.

**Literature**

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Principles of Macroeconomics

**W 3 credits 2V J.E. Sturm**

**Abstract**
This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?

**Objective**
This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to everyday economic problems.

**Content**
This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society’s resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

**Literature**
The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2467) contains announcements, course information and lecture slides.

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Financial Market Risks

**W 3 credits 2G D. Sornette**

**Abstract**
I aim to introduce students to the concepts and tools of modern finance and to make them understand the limits of these tools, and the many problems met by the theory in practice. I will put this course in the context of the on-going financial crises in the US, Europe, Japan and China, which provide fantastic opportunities to make the students question the status quo and develop novel solutions.
Objective

The course explains the key concepts and mechanisms of financial economics, their depth and then stresses how and why the theories and models fail and how this is impacting investment strategies and even a global view of citizenship, given the present developing crises in the US since 2007 and in Europe since 2010.

- Development of the concepts and tools to understand these risks and master them.
- Working knowledge of the main concepts and tools in finance (Portfolio theory, asset pricing, options, real options, bonds, interest rates, inflation, exchange rates)
- Strong emphasis on challenging assumptions and developing a systemic understanding of financial markets and their many dimensional risks

Content

1. The Financial Crises: what is really happening? Historical perspective and what can be expected in the next decade(s). Bubbles and crashes. The illusion of the perpetual money machine.

2. Risks in financial markets
   - What is risk?
   - Measuring risks of financial assets
   - Introduction to three different concepts of probability
   - History of financial markets, diversification, market risks

3. Introduction to financial risks and its management.
   - Relationship between risk and return
   - Portfolio theory: the concept of diversification and optimal allocation
   - How to price assets: the Capital Asset Pricing Model
   - How to price assets: the Arbitrage Pricing Theory, the factor models and beyond

4. Financial markets: role and efficiency
   - What is an efficient market?
   - Financial markets as valuation engines: exogeneity versus endogeneity (reflectivity)
   - Deviations from efficiency, puzzles and anomalies in the financial markets
   - Financial bubbles, crashes, systemic instabilities

5. An introduction to Options and derivatives
   - Calls, Puts and Shares and other derivatives
   - Financial alchemy with options (options are building blocks of any possible cash flow)
   - Determination of option value; concept of risk hedging

6. Valuation and using options
   - A first simple option valuation model
   - The Binomial method for valuing options
   - The Black-scholes model and formula
   - Practical examples and implementation
   - Realized prices deviate from these theories: volatility smile and real option trading
   - How to imperfectly hedge with real markets?

7. Real options
   - The value of follow-on investment opportunities
   - The timing option
   - The abandonment option
   - Flexible production
   - Conceptual aspects and extensions

8. Government bonds and their valuation
   - Relationship between bonds and interest rates
   - Real and nominal rates of interest
   - Term structure and Yields to maturity
   - Explaining the term structure
   - Different models of the term structure

9. Managing international risks
   - The foreign exchange market
   - Relations between exchanges rates and interest rates, inflation, and other economic variables
   - Hedging currency risks
   - Currency speculation
   - Exchange risk and international investment decisions

Lecture notes

Lecture slides will be available on the site of the lecture

Literature

Corporate finance
Brealey / Myers / Allen
Eight edition

+ additional paper reading provided during the lectures

Prerequisites / notice

none

363-1050-00L Conference of Disarmament: Simulation of Negotiations

W 3 credits 2S M. Ambühl

Abstract

The Global Studies Institute (University of Geneva) is organizing a simulation seminar on nuclear disarmament in collaboration with the Chair of Negotiation and Conflict Management (ETH), experts from the United Nations Institute for Disarmament Research and the Geneva Center for Security Policy.

Objective

The simulation is conducted in collaboration with experts and students during a two days seminar at the University of Geneva.

Students will have the possibility to participate in simulated diplomatic negotiations and to analyse and assess the negotiation logic behind the situations. They should gain insight in the basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general.
The simulation project is intended for Master's or Doctoral students of the Global Studies Institute (GSI) of the University of Geneva, of the ETH and for interested students of the Geneva Centre for Security Policy (GCSP). The simulation will be in French and English and is conducted by Prof. Calmy-Rey, former President of Switzerland.

In the lectures, students will be provided with basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general. Students will take the role of negotiators in the simulation (including the heads of the delegations), of keeper of the minutes or of observers and analysts.

Students will co-develop their mandates for the negotiation and be assisted by experts that are specialized in international negotiations as well as in the topic of disarmament. The negotiation tables will be chaired by former diplomats. Representatives of diplomatic missions in Geneva will play the role of the "Capitals" to which the heads of delegations will have to give account of the ongoing negotiations.

More details on the program, timetable, reading lists and performance assessment will be published here: https://chamilo.unige.ch/home/courses/M165/?id_session=0

The simulation will take place on the 26 and 27 November 2015 at the University of Geneva.

Languages: English and French

### Dates/Time/Location (GE = University of Geneva)

22 Sept. | ETH HG D 22 | 10:15-12:00 | Introduction
29 Sept. | GE Uni Mail Salle 1170 | 10:15-12:00 | Introduction to Negotiation Techniques (Dr. Vitalijs Butenko and Dr. Sibylle Zürcher, ETH)
6 Oct. | ETH HG D 16.2 | 10:15-12:00 | Preparation of the mandates for the FMCT (Fissile Material Cut-off Treaty)
13 Oct. | ETH HG D 22 | 10:15-12:00 | Preparation of the mandates for the FMCT (Fissile Material Cut-off Treaty)
20 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | No session; Students deepen and summarize their mandates on one page (A4)
27 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates I (FMCT)
10 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates II (HA)
17 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Preparation Meeting
26 & 27 Nov. | GE Salles 407 et 408 | 10:00-18:00 | Simulation at Uni Dufour
1 Dec. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the results

Note:
The participation in the simulation on 26. and 27. November in Geneva is necessary.
The two hours lectures on the 22. September, 6. and 13. October have to be attended in Zürich via conference call (ETH HG D 16.2). The other lectures during the semester can be attended via Skype.

To get the 3 ECTS, students have to participate at the 2 days simulation In Geneva, attend the 3 mandatory lecture parts via conference call an Zürich and write a report of 5 pages at the end of the course.

(technical note for registration: At this stage all registered students are on the waiting list)

### Content

#### 351-0555-00L Open- and User Innovation

**Abstract**
The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through their own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.

**Objective**
The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management and develop strategies to harness the value of user-developed ideas and contributions for firms and other organizations.

The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.

The course presents and builds upon recent research and challenges the students to devise innovation strategies that take into account the availability of user expertise, free and public knowledge, and the interaction with communities that span beyond one organization.

**Grading**
Grading is based on the final exam, the class presentations (including the slides) as well as class participation.

**Content**
This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through their own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structuration of technology, and an introduction to entrepreneurship.

**Lecture notes**
The slides of the lectures are made available and updated continuously through the SMI website:

**Literature**
Relevant literature for the exam includes the slides and the reading assignments. The corresponding papers are either available from the author online or distributed during class.

**Reading assignments:** please consult the SMI website:

### 351-0778-00L Discovering Management

#### Abstract

Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

**Objective**
Discovering Management combines in an innovate format a set of lectures and an advanced business game. The learning model for Discovering Management involves 'learning by doing'. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the students at all levels not belonging to D-MTEC. This course can be complemented with Discovering Management (Exercises) 351-0778-01.

**Content**
Discovering Management operates an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

**Objective**
Discovering Management combines in an innovate format a set of lectures and an advanced business game. The learning model for Discovering Management involves 'learning by doing'. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurship management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.
The lecture is based on the following book to be published in the summer of 2016:
B. Nowack

This course covers the bases for understanding micro- and macroeconomic issues and theories. Participants are given the tools to argue in
objective, corporate financial analysis, innovation, and business model innovation. Practical examples from industry experts will stimulate
the students to critically assess these issues. Creative skills will be trained by the business game exercise, a participant-centered learning
activity, which provides students with the opportunity to place themselves in the role of Chief Innovation Officer of a large multinational
corporation. As they learn more about the specific case and identify the challenge they are faced with, the students will have to develop an
innovative business case for this multinational corporation. Doing so, this exercise will provide an insight into the context of managerial
problem-solving and corporate innovation, and enhance the students' appreciation for the complex tasks companies and managers deal
with. The business game presents a realistic model of a company and provides a valuable learning platform to integrate the increasingly
important development of the skills and competences required to identify entrepreneurial opportunities, analyze the future business
economy and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

701-0747-00L Environmental Policy of Switzerland I W 3 credits 2V E. Lieberherr
Abstract
This course presents the basics of policy analysis and the specific characteristics of Swiss environmental policy. Policy instruments, actors
and processes are addressed both theoretically as well as by means of current Swiss environmental policy examples.

701-0757-00L Principles of Economics W 3 credits 2G R. Schubert
Abstract
This course covers the basics for understanding micro- and macroeconomic issues and theories. Participants are given the tools to argue in
economic and political terms and to evaluate the corresponding measures. Group and individual exercises deepen the knowledge gained.

701-0985-00L Social Intercourse with Current Environmental Risks W 1 credit 1V B. Nowack, C. M. Som-Koller
Abstract
The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case
studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be
applied to deal with environmental risks and how they can be used for sustainable innovation.

701-0727-00L Politics of Environmental Problem Solving in Developing Countries W 2 credits 2G U. Scheidegger
Abstract
The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in
environmental politics at the example of specific environmental challenges of global importance.
Objective

After completion of the module, students will be able to:
- Identify and appraise ecological aspects in development cooperation, development policies and developing countries’ realities
- Analyze the forces, components and processes, which influence the design, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

Content

Key issues and basic concepts related to environmental politics are introduced. Then the course predominantly builds on case studies, providing information on the context, specifying problems and potentials, describing processes, illustrating the change management, discussing experiences and outcomes, successes and failures. The analysis of the cases elucidates factors for success and pitfalls in terms of processes, key elements and intervention strategies.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management:

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008

Lecture notes

Information concerning the case studies and specific issues illustrated therein will be provided during the course (uploaded on Moodle)

Literature


Prerequisites / notice

The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the sources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

★★ Philosophy

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0125-03L</td>
<td>Research Colloquium for Ph.D.-Students and Members of Staff ■ Open for Master students on personal invitation. Personal registration required to Mr. Wingert.</td>
<td>Z</td>
<td>0</td>
<td>1K</td>
<td>L. Wingert</td>
</tr>
<tr>
<td>851-0125-41L</td>
<td>Introduction into Philosophy of Technology Particularly suitable for students of D-ITET, D-MATL, D-MAYVT</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>O. Müller</td>
</tr>
<tr>
<td>851-0125-58L</td>
<td>Philosophy of the Environmental Sciences: An Introduction Particularly suitable for students of D-ARCH, D-BSSSE, D-CHAB, D-MTEC, D-USYS</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>A. Schwarz</td>
</tr>
<tr>
<td>851-0125-60L</td>
<td>Introduction to Epistemology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>N. El Kassar</td>
</tr>
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</table>
Objective - conceptions of fundamental epistemological concepts
- sensitivity to epistemological questions
- capacity to reflect epistemological theories
- capacity to discuss epistemological theories
- reading and interpreting philosophical texts (including English texts)

851-0125-18L Self-Ownership - Philosophical and Juridical Perspectives  W  3 credits  2G

Abstract Rights in Objects are founded on an inalienable Self-Ownership. These ideas are central for personal rights. We speak of my body, my genes, my name, my portrait, my ideas or ways of expression.

Objective Participants will make acquaintance with founding texts of the natural rights property concept (John Locke). They will see the connection between inalienable self-ownership, prohibition of slavery, derivative commercial rights and modern personal rights. They will learn about the problems of self-ownership today concerning property in one's body and intellectual property. Critical alternatives to the property paradigm will be discussed.

Participants will have the opportunity to gain access to unfamiliar texts from the philosophical tradition and to see their relevance today. They experience the consequences of a certain use of concepts and orient themselves in current bioethical, juridical and political discussions.

Content Texts by Locke, Nozick, Christman, Otsuka, Rasmussen, Schneider, Stirner, Fichte and Forschner. Founding of property right in self-ownership (Locke), revival of this concept in Nozick and his egalitarian critics. Critique of the concept of self-ownership related to property in one's body. Looking back to the personal self-relatedness that comes up again in Intellectual Property and in modern personal rights.

Literature Text, Seminarplan und Literaturliste in ILIAS Lehrdokumentenablage.

851-0125-51L Man and Machine Particularly suitable for students of D-CHAB, D-HEST, D-MAVT, D-MATL  W  3 credits  2G  M. Hampe

Abstract The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different models of machines will be important here: the clockwork, the steam engine and the computer.

Objective On the one hand models of machines had a heuristical value in research on man, e.g. in Harvey's discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these models were always criticised, sometimes polemically, because they are supposedly not adequate for man. Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

851-0125-61L What is the Value of Truth? Particularly suitable for students of D-CHAB, D-HEST, D-MAVT, D-MATL  W  3 credits  2G  L. Wingert

Abstract It is useful to know which fellowships are available or to know the causes of frequent occurrence of extreme weather. These truths are of instrumental value. Is it also intrinsically good to know the truth, e.g. to know that there are gravitational waves? And which is the role of truth in our lives? The course will deal with such philosophical questions.


3. Ebenso soll ein besseres Urteil gebildet werden darüber, welche existenzielle Rolle die Suche nach Wahrheiten in unserem persönlichen Leben hat.


Abstract How should we human beings understand ourselves according to our best knowledge about us, the social world, human history and nature? What are the relationships between biological and socio-cultural determinants of our thinking and doing? Michael Tomasello, psychologist, and social philosopher, has answered these questions in a thought provoking way. His answers will be studied and examined.


851-0125-63L Images of Mathematics Particularly suitable for students of D-MATH  W  3 credits  2G  M. Hampe, A. Schubbach

Abstract The lecture series "Images of Mathematics" deals with the formalization of the objects and the logical language of mathematics from Hilbert to Gödel and considers its consequences in view of our conception of mathematical practice and knowledge, the limits of calculability and computability in mathematics, and the relation between the logical proof procedures and the involved intuitive aspects.

Objective The lecture series will present philosophical problems of theoretical mathematics in the 20th century and will discuss the consequences of formalization and axiomatization. It aims at a critical reflection on the modern images of mathematics.
Should science be free from moral, political or ideological influences? According to the so-called value-free ideal it should. Many scientists

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical

Yet, the deeper mathematics dug into its foundations, the more radical the problems became. Finally, the optimistic Hilbert program

Moreover, Gödel’s theorems open many far-reaching and intriguing questions in view of our image of mathematics, questions concerning

For further reading (optional): Mark van Atten and Juliette Kennedy, Gödel’s Logic, in: Handbook of the History of Logic, Vol 5: Logic from

The lecture series "Images of Mathematics" deals with a few moments in the history of the scientific discipline since the middle of the 19th

The main goal of this course is to enhance the student’s ability to:

- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international,

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games,

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 621 of 1571
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

Narratives of Health and Illness

851-0145-05L
Number of participants limited to 30

Particularly suitable for students of D-HEST

Abstract
Das Seminar gibt einen Einblick in den Forschungsbereich der Narrativen Medizin als Teilbereich der Medizinischen Geisteswissenschaften. Erzählungen spielen eine vielfältige Rolle, wenn es um Gesundheit und Krankheit geht
Ziel der Veranstaltung ist es, eine eigenständige kritische Perspektive auf Erzählungen von Gesundheit und Krankheit zu ermöglichen. Im Seminar werden daher unterschiedliche Arten von aktuellen Texten und Materialien zur Rolle von medizinischen Narrativen kritisch miteinander diskutiert.

851-0148-04L Cyclical time
W 3 credits 2S  T. Böhm
Abstract
The idea of cyclical time is found in ancient pieces of wisdom (Pythagoreans, Plato, Buddhism) as reincarnation or memory, but also in Nietzsche as eternal return, in Deleuze as repetition, in Freud as repetition compulsion. We investigate the concept of repetition in combination with difference as a positive mode of thinking change.
Objective
Understanding of the various forms and functions of repetition on the basis of texts by Plato (anamnesis), Freud (repetition compulsion), Kierkegaard (narration), Nietzsche (eternal return as cosmological and ethical principle), Deleuze (time synthesis and repetition of the future), Poincaré theorem of recurrence.

851-0144-20L Philosophical Aspects of Quantum Physics
W 3 credits 2S  N. Sieroka, R. Renner
Particularly suitable for students of D-CHAB, D-PHYS
Abstract
This course provides an introduction to philosophical issues surrounding quantum physics. In particular, we will examine different interpretations of quantum mechanics (such as the many-world interpretation) and the transition between the quantum and the classical physical realm (here phenomena such as decoherence will be highlighted).
Objective
By the end of the course students are able to describe and compare different interpretations of quantum mechanics. They are able to identify and examine issues concerning these different interpretations and issues concerning the transition between quantum and classical descriptions in physics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific contexts.

851-0144-19L Philosophy of Time
W 3 credits 2V  N. Sieroka
Particularly suitable for students of D-BIOL, D-INFK, D-MATH, D-PHYS
Abstract
This course provides an introduction to philosophical issues surrounding the concept of time. We will treat topics such as: the existence of past, present, and future; the possibility of time travel; the constitution of time consciousness and its possible neurophysiological counterparts; temporal biases in the conduct of our lives; responsibility to future and past generations.
Objective
By the end of the course students are able to describe and compare different theories and concepts of time (physical time, perceptual time, historical time ...). They are able to identify and examine issues concerning time as they occur in various philosophical subdisciplines - especially in philosophy of science, philosophy of mind, metaphysics, and ethics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific and social contexts.
Part of the course reflects on methods and contents from physics, neuroscience/cognitive science, and logic.

851-0144-21L Philosophical Issues and Problems in Theoretical Computer Science
W 3 credits 2V  G. Sommaruga, J. Copeland, D. Proudfoot
Particularly suitable for students of D-INFK
Abstract
This course studies philosophical issues concerning computers and computing. Topics include: information (and information content), computational complexity, the Turing Test for computer thought; the "Chinese Room" argument against the possibility of strong AI; connectionist AI; consciousness; the Church-Turing thesis; computational and hypercomputational models of mind; and free will.
Objective
- Exhibit a general understanding of the philosophy and history of computing.
- Explain central problems in the field and their potential solutions, independently and at a level requiring in-depth knowledge and critical understanding.
- Communicate clearly in writing about topics in this field.

851-0144-22L Developments in Logic after Gödel: Applications to Theoretical Computer Science
W 3 credits 2V  G. Sommaruga, J. Copeland
Particularly suitable for students of D-INFK
Abstract
The course will start by presenting a modern logic, namely (propositional) modal logic, which has turned out to be extremely fruitful and to have numerous interesting applications in computer science, mathematics and philosophy. Subsequently, two of these applications to computer science, tense logic and dynamic logic, and one application to mathematics, provability logic, will be introduced.
Objective
- Learn the fundamental concepts of a range of propositional logics
- Learn how to construct proofs in these logics
- Study the interface between mathematical logic and computer science, and mathematical logic and mathematics

851-0127-28L Death - The Secret Problem of Life
W 3 credits 2S  H. Wiedebach
Abstract
No detective novel without a corpse, no religion without knowledge about death and life, no large transplantation of an organ without certificate for the donor's death. Is a dead person always a corpse? - Death is part of life and yet stands simultaneously in opposition to it. We cling to life and nonetheless wish to have the option to commit suicide. Do we know what we really want in that case?
Objective
- Understand several conceptions of death in history, 2) determine the concept of death in a medical sense (brain-death, etc.).
- The search for a personal view about life and death. 4) The practice of a precise manner of speaking based on reflection.
Literature
Texte als Diskussionsgrundlage werden zu Beginn des Semesters genannt bzw. als PDF unter "Lernmaterialien" veröffentlicht.
Prerequisites / notice
- Leistungsnachweise der Studenten:
  - Es besteht Anwesenheitspflicht. Einmaliges Fehlen ist möglich mit Entschuldigung. Als Ersatz wird eine 4-seitige Darstellung geliefert.
  - Ab dem 2. Seminartermin erfolgt im Voraus pro Sitzung (d.h. insgesamt 6mal) eine 2-seitige Darstellung bzw. Stellungnahme zu einem vorgegebenen Text.
  - Die 2-seitigen Darstellungen müssen bis Dienstag Abend in der Woche vor der nächsten Sitzung vorliegen, damit wir Zeit haben, sie zu lesen.
  - Statt einer der 6 Kurzdarstellungen kann ein einführendes Referat (15 min, max. 2 Personen) gehalten werden.
  - MA-Studenten Philosophie und Geschichte des Wissens schreiben zusätzlich einen 5-seitigen Essay zu Michael Theunissen: "Die Gegenwart des Todes im Leben".
  - Ihre Texte schicken Sie bitte an die eigens eingerichtete Email-Adresse: grundproblem-tod@ethz.ch
  - Formalia (Minimalanforderungen);
    - Schriftbild: Zeilenabstand 1.5, Schriftgröße 12, Seitenabstand 2.5cm, Schriftart: Arial, Times New Roman.
    - Vor- und Nachname, Matrikelnummer, Veranstaltungsname, Dozent, E-Mail-Adr., Studiengang.
    - organisatorische Rückfragen bitte an den Assistenten Raphael Salvi: raphael.salvi@phil.gess.ethz.ch

701-0701-00L Philosophy of Science
W 3 credits 2V  G. Hirsch Hadrorn, C. J. Baumberger
The lecture explores various strands in philosophy of science in a critical way, focusing on the notion of rationality in science, especially with regards to environmental research. It addresses the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

Students learn to engage with problems in the philosophy of science and to relate them to natural and environmental sciences, thus developing their skills in critical thinking about science and its use. They know the most important positions in philosophy of science and the objections they face. They can identify, structure and discuss issues raised by the use of science in society.

1. Core differences between classical Greek and modern conceptions of science.
2. Classic positions in the philosophy of science in the 20th century: logical empiricism and critical rationalism (Popper); the analysis of scientific concepts and explanations.
3. Objections to logical empiricism and critical rationalism, and further developments: What is the difference between the natural sciences, the social sciences and the arts and humanities? What is progress in science (Kuhn, Fleck, Feyerabend)? Is scientific knowledge relativistic? What is the role of experiments and computer simulations?
4. Issues raised by the use of science in society: The relation between basic and applied research; inter- and transdisciplinarity; ethics and accountability of science.

A reader will be available for students.

A list of introductory literature and handbooks will be distributed to the students.

Further optional exercises accompany the lecture and offer the opportunity for an in-depth discussion of selected texts from the reader. Students receive an additional credit point. They have to sign up separately for the exercises for the course 701-0701-01 U.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0701-01L</td>
<td>Philosophy of Science: Exercises</td>
<td>W</td>
<td>1</td>
<td>U</td>
<td>G. Hirsch Hadorn, C. J. Baumberger</td>
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<tr>
<td>701-0703-00L</td>
<td>Environmental Ethics</td>
<td>W</td>
<td>2</td>
<td>V</td>
<td>M. Huppenbauer</td>
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<tr>
<td>851-0121-32L</td>
<td>Introduction to Ethics of Science</td>
<td>W</td>
<td>3</td>
<td>S</td>
<td>N. Mazouz</td>
</tr>
<tr>
<td>851-0594-00L</td>
<td>International Environmental Politics</td>
<td>W</td>
<td>3</td>
<td>V</td>
<td>T. Bernauer</td>
</tr>
</tbody>
</table>

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This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory.

Lectures notes
Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link ‘Registered students, please click here for course materials’ at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <michaehu@student.ethz.ch>). All assigned papers must be read ahead of the respective meeting. Following the course on the basis of on-line slides and papers alone is not sufficient. Physical presence in the classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GESS library at the IFW building, Haldeneggsteig 4, B-floor, or in the library of D-USYS.

Literature
Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link ‘Registered students, please click here for course materials’ at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <michaehu@student.ethz.ch>).

Prerequisites / notice
None

851-0589-00L Technology and Innovation for Development
W Dr 3 credits 2V P. Aerni

Abstract
Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects.

Objective
- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology
- improved understanding of the role of science and technology in the context of human and societal development

Content
Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies.

The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

Lecture notes
Reader with issue-specific articles. E-version is partly available under https://www.ethz.ch/content/specialinterest/gess/cis/international-relations/en/teaching/materials/tech.html
Literature


Prerequisites / notice

The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester.

The class will be taught in English.

Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

853-0038-00L Swiss Foreign Policy W 3 credits 2V D. Möckli

Abstract

This course analyzes the foundations and challenges of Swiss foreign policy. After reviewing the history of foreign policy conceptions since the early 20th century, we will discuss the determining factors of Swiss foreign policy and examine, together with guest speakers from the foreign ministry, current issues such as the Syria crisis, the migration challenge, terrorism, and Swiss-EU relations.

Objective

Students should acquire a solid understanding of Swiss foreign policy and the relevant academic and political debates associated with it.

Auf dieser Basis werden wir die derzeitigen weltpolitischen Entwicklungslieningen und deren Bedeutung für die Schweiz analysieren. Zu den ausserpolitischen Herausforderungen und Themen, die wir diskutieren, gehören die Syrienkrise und andere Konflikte im Nahen und Mittleren Osten, die Ukrainekrise und das Engagement in der OSZE, die Friedensförderungspolitik der Schweiz generell, die Entwicklungszusammenarbeit, die ausserpolitischen Beiträge zur Bewältigung der Migrationskrise, das Engagement der Schweiz gegen den Terrorismus, die Europapolitik und die Politik in der UNO.


Students will receive a handout of slides accompanying the lectures.

The course will be supported by an e-learning environment.

### Lecture notes

A reading list will be handed out at the beginning of the semester.

### Literature

Students will receive a handout of slides accompanying the lectures.

The course will be supported by an e-learning environment.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Module</th>
<th>Prerequisites / notice</th>
</tr>
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<tbody>
<tr>
<td>853-0047-01L</td>
<td>World Politics Since 1945: The History of International Relations (Without Exercises)</td>
<td>3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>853-0060-00L</td>
<td>Current Issues in Security Policy</td>
<td>3</td>
<td>V</td>
<td></td>
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<tr>
<td>853-0033-00L</td>
<td>Leadership I</td>
<td>3</td>
<td>V</td>
<td></td>
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<tr>
<td>853-0015-01L</td>
<td>Conflict Research I: Causes of War in Historical Context (without exercises)</td>
<td>3</td>
<td>V</td>
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<tr>
<td>853-0302-01L</td>
<td>European Integration (Seminar without Tutorial)</td>
<td>2</td>
<td>S</td>
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</tbody>
</table>

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Content
1. Introduction
2. Theories of European integration
3. The development of European integration
4. Internal market and monetary union
5. Internal and external security policies
6. Constitutionalization
7. Widening and differentiation
8. Switzerland, the EEA, and EU neighbourhood policies
9. Identity, trust, and solidarity
10. Public spheres, parties, and elections
11. Decision-making and policy development in the EU
12. Statehood and democracy in the EU
13. European integration in crisis

Lecture notes
The seminar covers the theory, development, and core policy fields of European integration as well as structures and processes of the EU as a decision- and policy-making system.

Literature
Basislektüre

Prerequisites / notice
The grade is based on a written exam.

860-0001-00L Public Institutions and Policy-Making Processes

W 3 credits 3G T. Bernauer, S. Bechtold, F. Schimmelfennig
Number of participants limited to 25.
Priority for Science, Technology, and Policy MSc students.

Abstract
Students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels, and what challenges arise in this regard.

Objective
Public policies result from decision-making processes that take place within formal institutions of the state (parliament, government, public administration, courts). That is, policies are shaped by the characteristics of decision-making processes and the characteristics of public institutions and related actors (e.g. interest groups). In this course, students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels, and what challenges arise in this regard. The course is organized in three modules. The first module (Stefan Bechtold) examines basic concepts and the role of law, law-making, and law enforcement in modern societies. The second module (Thomas Bernauer) deals with the functioning of legislatures, governments, and interest groups. The third module (Frank Schimmelfennig) focuses on the European Union and international organisations.

Content
Schedule (for up-to-date information, see the syllabus that will be distributed to participants electronically):
W1: Bechtold, Bernauer: Introduction
How are laws created and interpreted? How are they enforced?
W2: Bechtold: Why do we need laws and why do people and firms usually obey the law? What are possible goals of legal systems? What is the relationship between laws, social norms, and moral values?
W3: Bechtold: What role does scientific evidence play in the creation and enforcement of the law? How does the law deal with non-quantifiable factors or incommensurable values?
W4: no class
W5: Bernauer: How are parliaments (legislatures) elected, how do they work, and how do their characteristics and processes affect policy-making?
W6: Bernauer: Why do forms of government differ and how does this affect policy-making? Why and in what respect are public administrations efficient/effective, and why sometimes not?
W7: Bernauer: How do interest groups and social movements affect policy-making.
W8: Study week
W9: Schimmelfennig: Governance beyond the state: why and how states create international institutions.
W10: Schimmelfennig: International organizations and regimes: case studies of global governance.
W11: Schimmelfennig: Institutions and policy-making in the European Union.
W12: Schimmelfennig: International organizations and policy diffusion.
W13: End-of-semester exam

An add-on module to this course (3 ECTS) involves an essay. This part of the course is accessible only to ISTP MSc students and requires enrollment in the main course (3 ECTS). ISTP MSc students must enrol in both parts. Other students can only enrol in the main course. 3rd week of January: deadline for review essay

Lecture notes
Reading materials will be distributed electronically to the students when the semester starts.
This course offers a comprehensive examination of the role of international organizations (IOs) in world politics. Besides teaching the basic theories and methods that are necessary for studying IOs, this course considers the application of those theories and methods to a range of special institutions.

The first part of this course offers an introduction and will seek to explain how, if at all, IOs obtain some measure of authority in international affairs, i.e., why states delegate certain tasks to IOs instead of dealing unilaterally or multilaterally outside of an institutional context. The second part of the course focuses on the impact and effectiveness of international institutions. We assess whether and how IOs influence state compliance with agreements, and whether IOs socialize states to behave in certain ways. The third and final part of the course examines a special set of IOs: international alliances and international regimes, i.e., explicit principles, norms, rules, and decision-making procedures that define expected behavior in a specific problem field.

The requirements for the course include participation in class discussions (10%), one class presentation (30%), and a final exam (60%).

a) Participation: The quality of students' experience in this course depends on the participation of students. Regular attendance and active class participation constitute a significant portion of the course grade. Students will be expected to read the required readings, think critically about them, and discuss them in class.

b) Class Presentation: First, you will submit one short (maximum 2 pages) paper summarizing the readings for a particular week. This short paper should be distributed to the class ahead of the meeting time (email, at least 24 hours in advance). Each student writing such a paper must also prepare a short class presentation. The goal of this exercise is not simply to summarize the assigned readings, as others in the class will already be familiar with the assignment. Rather, a good summary discusses the broader issues, themes, and questions underlying the readings or identifies problems with research design or potential flaws in the particular articles. The paper(s) and presentation(s) serve as a starting point for a more focused in-class discussion.

c) Final exam: The final examination will take place at the last week of the course. It lasts 1.5 hours, during which you will be required to critically analyze the readings or identify potential problems with research methods.

## Literature


This is a Master level course. The course is capped at 25 students, with ISTP Master students having priority.
Cognition in Architecture - Designing Orientation and Taking the perspectives of building users (occupants and visitors) is vital for a human-centered design approach. Students will learn about to learn and understand how our sense of time influences our motivation, cognition, and emotion and to learn that our sense of time is time immersion, time specificity, time speed, time texture, time horizon, time motion, time embodiment, and lifetime localization. Our sense of time can (often unconsciously) have profound effects on our motivation, cognition, and emotion.

851-0252-01L Human-Computer Interaction: Cognition and Usability
W 3 credits 2S I. Barisic, C. Hölscher, S. Ognjanovic

Objective
This seminar will introduce key topics, theories and methodology in human-computer interaction (HCI) and usability. Presentations will cover basics of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that first familiarize themselves with a select usability evaluation method (e.g. user testing, GOMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the plenary. Active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay / report will be required (details to be specified in the introductory session of the course).

Abstract
This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects

851-0252-03L Cognition in Architecture - Designing Orientation and Navigation for Building Users
W 3 credits 2S V. Schinazi, B. Emo Nax, C. Hölscher

Objective
This seminar will provide an opportunity to experience some of the methods in applied group projects

Abstract
This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects

851-0252-04L Behavioral Studies Colloquium

Objective
This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students to develop their ideas in relation to behavioral science. The colloquium also features invited research talks.

Abstract
This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students to develop their ideas in relation to behavioral science. The colloquium also features invited research talks.

Content
Students know and can apply autonomously up-to-date investigation methods and techniques in the behavioral sciences. They achieve the ability to develop their own ideas in the field and to communicate their ideas in oral presentations and in written papers. The credits will be obtained by a written report of approximately 10 pages.

851-0253-03L The Sense of Time and Its Effects on Motivation, Cognition, and Emotion
W 2 credits 2S K. Stocker

Objective
While time is studied prominently in physics, it is also an integral part of our mind. Some of the main parameters of our sense of time are time immersion, time specificity, time speed, time texture, time horizon, time motion, time embodiment, and lifetime localization. Our sense of time can (often unconsciously) have profound effects on our motivation, cognition, and emotion.

Abstract
While time is studied prominently in physics, it is also an integral part of our mind. Some of the main parameters of our sense of time are time immersion, time specificity, time speed, time texture, time horizon, time motion, time embodiment, and lifetime localization. Our sense of time can (often unconsciously) have profound effects on our motivation, cognition, and emotion.

851-0252-02L Introduction to Cognitive Science
W 3 credits 2V V. Schinazi, L. Konieczny, T. Thrash

Objective
Cognitive Science views human cognition as information processing and provides an inter-disciplinary integration of approaches from cognitive psychology, informatics (e.g., artificial intelligence), neuroscience and anthropology among others. The lectures provide an overview of basic mechanisms of human information processing and various application domains. A focus will be on matters of knowledge acquisition, representation and usage in humans and machines. Models of human perception, reasoning, memory and learning are presented and students will learn about experimental methods of investigating and understanding human cognitive processes and representation structures.

227-0802-01L Social Psychology
W 2 credits 2G H. D. Daniel, R. Mutz
Im Einzelnen sollen die Teilnehmerinnen und Teilnehmer lernen:

- an den Beispielen von Kaufverhalten oder ökologischem Verhalten zu beschreiben, wie Normen und Einstellungen Einfluss auf das Verhalten nehmen.
- Die Subjektivität und die Fehlerquellen sozialer Wahrnehmung verstehen,
- Prinzipien der Psychologie der Kommunikation zu nutzen für eine Verbesserung der Kommunikation in Studium und Beruf,
- Merkmale und Strukturen von Gruppen zu identifizieren und mit geeigneten Methoden zu analysieren,
- Die Grundlagen von Konformität und Gehorsam gegenüber Autoritäten zu kennen,
- Gruppenphänomene wie soziales Faulenzen, Risiko- und Konservativmusch-Schub und Gruppendenken entgegenzuwirken,
- Gruppenleistungen und -entscheidungen zu optimieren.
- Führungsstile zu unterscheiden lernen,
- Techniken zur Moderation von interagierenden Gruppen kennen zu lernen.

Lecture notes: kein Skript


Prerequisites / notice: Es werden für D-ITET-Studierende Gruppenarbeiten (6 Kreditpunkte) in Form eines 3-tägigen computer-unterstützten Assessments fachübergreifender Kompetenzen angeboten (Teilnehmerzahl beschränkt auf 12 Studierende). Die Teilnehmenden verfassen Berichte, die benotet werden.

<table>
<thead>
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<td>363-0311-00L</td>
<td>Psychological Aspects of Risk Management and Technology</td>
<td>W</td>
<td>3</td>
<td>G. Grote, J. Schmutz, R. Schneider, M. Zumbühl</td>
</tr>
<tr>
<td>701-0721-00L</td>
<td>Psychological Aspects of Risk Management and Technology</td>
<td>W</td>
<td>3</td>
<td>R. Hansmann, C. Keller, M. Siegrist</td>
</tr>
<tr>
<td>851-0252-08L</td>
<td>Cognition in Studio Design - Analytic Tools for Evidence-Based Design</td>
<td>W</td>
<td>3</td>
<td>B. Emo Nax, M. Brösmale, C. Hölscher</td>
</tr>
<tr>
<td>851-0238-01L</td>
<td>Support and Diagnosis of Knowledge Acquisition Processes (EW3)</td>
<td>W</td>
<td>3</td>
<td>L. Schalk, P. Edelsbrunner, S. Hofer</td>
</tr>
</tbody>
</table>
In this seminar students learn advanced techniques to support and to diagnose knowledge acquisition processes in school.

This class introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered.

Students are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes.

Basic concepts of law, sources of law, Private law: Contract law (particularly contract for work and services), tort law, property law. Public law: Human rights, administrative law, procurement law, procedural law. Insights into the law of the EU and into criminal law.

Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library)

Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=2170).

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<tr>
<td>851-0703-00L</td>
<td>Introduction to Law</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>O. Streiff Gnöpff</td>
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<tr>
<td>851-0705-02L</td>
<td>Environmental Law: Topics and Case Studies</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>C. Jäger</td>
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<tr>
<td>851-0707-00L</td>
<td>Space Planning Law and Environment</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>O. Bucher</td>
</tr>
<tr>
<td>851-0709-00L</td>
<td>Introduction to Civil Law</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>H. Peter</td>
</tr>
</tbody>
</table>
Participants are acquiring a comprehensive summary about the system Traffic Law/Traffic Commercial Law in Switzerland. With practical exercises and subsequent detailed reviews themes and subjects of special interest to participants are being treated more thoroughly. Particularly suitable for students of D-ITET, D-MAVT

**Objective**


**Content**

Le cours de droit civil porte notamment sur le droit des obligations (droit des contrats et responsabilité civile) et sur les droits réels (propriété, gages et servitudes). De plus, il est donné un bref aperçu du droit de la procédure et de l'exécution forcée.

**Literature**

Editions officielles récentes des lois fédérales, en langue française (Code civil et Code des obligations) ou italienne (Codice civile e Codice delle obbligazioni), disponibles auprès de la plupart des bibliothèques.

Sont indispensables:
- le Code civil et le Code des obligations;
- Sont conseillés:
  - Nef, Urs Ch., Le droit des obligations à l'usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
  - Boillot, J.-P.: Manuel de droit, éd Slatkine, Genève

**Prerequisites / notice**

Remarques:
- Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours "Recht I" et "Recht II" en langue allemande et des exercices y relatifs.
- Les examens peuvent se faire en français ou en italien.
- Examen au 1er propédeutique, convient pour travail de semestre.

<table>
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<tr>
<th>Code</th>
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<th>Credits</th>
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<tr>
<td>851-0727-02L</td>
<td>E-Business-Law</td>
<td></td>
<td>2</td>
<td></td>
<td>D. Rosenthal</td>
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</tbody>
</table>

**Abstract**

The course deals with the basic legal framework for doing e-business as well as using information technology. It discusses a variety of legal concepts and rules to be taken into account in practice, be it when designing and planning new media business models, be it when implementing online projects and undertaking information technology activities.

**Objective**

The objective is knowing and understanding key legal concepts relevant for doing e-business, in particularly understanding how e-business is regulated by law nationally and internationally, how contracts are concluded and performed electronically, which rules have to be obeyed in particular with Internet with regard to third party and own content and client data, the concept of liability applied in e-business and the role of the law in the practical implementation and operation of e-business applications.

**Content**

Vorgesehene Strukturierung der Vorlesung:

1) Welches Recht gilt im E-Business?
   Internationalität des Internets
   Regulierten Branchen

2) Gestaltung und Vermarktung von E-Business-Angeboten
   Verwendung fremder und Schutz der eigenen Inhalte
   Haftung im E-Business (und wie sie beschränkt werden kann)
   Domain Namen

3) Beziehung zu E-Business-Kunden
   Verträge im E-Business, Konsumentenschutz
   Elektronische Signaturen
   Datenschutz
   Spam

4) Verträge mit E-Business-Providern

**Lecture notes**

Es wird mit Folien gearbeitet, die als PDF über die elektronische Dokumentenablage (ILIAS) auf dem System der ETHZ vorgängig abrufbar sind. Auf dem Termin- und Themenplan (ebenfalls online abrufbar) sind Links zu Gesetzesstexten und weiteren Unterlagen abrufbar. Schriftlich wird jede Vorlesung auch als Podcast aufgezeichnet, der jedoch nur für die Studierenden mit einem Passwort (erhältlich beim Dozenten) zugänglich ist.


**Literature**


**Prerequisites / notice**

Die Semesterendprüfung ist in Form eines schriftlichen Kurztests (normalerweise MC) in voraussichtlich der letzten Doppelstunde geplant. Es wird angegeben, welche Unterlagen beim jeweiligen Thema den Prüfungsstoff definieren. Der Test wird möglicherweise elektronisch durchgeführt.


Ferner bietet Ursula Widmer eine Vorlesung zum Thema Informationssicherheit an, welche die rechtlichen Aspekte der Sicherheit von ICT-Infrastrukturen und Netzen und der transportierten und verarbeiteten Informationen.

<table>
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<td>Traffic Law / Traffic Commercial Law</td>
<td></td>
<td>2</td>
<td></td>
<td>S. Scherler</td>
</tr>
</tbody>
</table>

**Abstract**

Within the scope of the lecture "Traffic Law / Traffic Commercial Law", besides an introduction into the legal basis of the national and international traffic, the main interest will be laid on actual political and economical questions and problems with respect to traffic (e.g. financing of traffic, road pricing, rail reform, air traffic vs. environment law etc.).

**Objective**

Participants are acquiring a comprehensive summary about the system Traffic Law/Traffic Commercial Law in Switzerland. With practical exercises and subsequent detailed reviews themes and subjects of special interest to participants are being treated more thoroughly.

**Content**

Within the scope of the lecture "Traffic Law / Traffic Commercial Law", besides an introduction into the legal basis of the national and international traffic, the main interest will be laid on actual political and economical questions and problems with respect to traffic (e.g. financing of traffic, road pricing, rail reform, air traffic vs. environment law etc.). With practical exercises and subsequent detailed reviews themes and subjects of special interest to participants are being treated more thoroughly.

**Lecture notes**

Script will be distributed during the lecture.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>W</th>
<th>Credits</th>
<th>V</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0735-10L</td>
<td>Business Law</td>
<td></td>
<td>2</td>
<td></td>
<td>P. Peyrot</td>
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</tbody>
</table>

**Abstract**

The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.
The students shall obtain the following competence:
- They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise.
- They shall be acquainted with corporate functions as contracting, negotiation, claims management and dispute resolution.
- They shall be familiar with the issues of corporate compliance, i.e. the system to ascertain that all legal and ethical rules are observed.
- They shall be able to contribute to the legal management of the company and to discuss legal issues.
- They shall have an understanding of the law as a part of the corporate strategy and as a valuable resource for the company.

A comprehensive script will be made available online on the moodle platform.

**Objective**

**Workshop and Lecture Series in Law and Finance**  
W 2 credits 2S G. Hertig

**Abstract**

The Workshop and Lectures Series in Law & Finance is a joint seminar of ETH Zurich, the University of Zurich and the University of St. Gallen. Each semester, several guest scholars from law, finance and related fields give a lecture and/or discuss their ongoing research. All speakers are internationally well-known experts from Europe, the U.S. and beyond.

**Objective**

The Lecture and Workshop Series in Law & Finance aims at allowing participants to discuss current financial regulation and corporate governance issues with leading academics.

**Content**

Participants discuss current Law & Finance issues with guest scholars from the U.S. and the U.S. In addition, participants write a comment on one of the discussed papers.

**Lecture notes**

To be discussed papers are posted in advance on the course's web page.

**Literature**

- Viral Acharya et al., Regulating Wall Street (Wiley 2011)

**Workshop & Lecture Series on the Law & Economics of Innovation**  
W 2 credits 2S S. Bechtold, H. Gersbach, A. Heinemann

**Objective**

This series is a joint project by ETH Zurich and the University of Zurich. It provides an overview of interdisciplinary research on intellectual property, innovation, antitrust and technology policy. Scholars from law, economics, management and related fields give a lecture and/or present their current research. All speakers are internationally well-known experts from Europe, the U.S. and beyond.

**Content**

After the workshop and lecture series, participants should be acquainted with interdisciplinary approaches towards intellectual property, innovation, antitrust and technology policy research. They should also have an overview of current topical issues of international research in these areas.

**Lecture notes**

Papers discussed in the workshop and lecture series are posted in advance on the course web page.

**Literature**

- Suzanne Scotchmer, Innovation and Incentives, 2004
- Bronwyn Hall / Nathan Rosenberg (eds.), Handbook of the Economics of Innovation, 2 volumes, Amsterdam 2010
- Bronwyn Hall / Dietmar Harhoff, Recent Research on the Economics of Patents, 2011
- Bronwyn Hall / Dietmar Harhoff, Recent Research on the Economics of Patents, 2011
- Dennis Carlton / Jeffrey Perloff, Modern Industrial Organization, 4th edition, 2004

**Environmental Regulation: Law and Policy**  
W 3 credits 1S

**Objective**

The course will be offered again in the spring semester 2017.

**Number of participants limited to 15.**

**Abstract**

The aim of this course is to make students with a technical scientific background aware of the legal and political context of environmental policy in order to place solutions in their regulatory context.

**Objective**

The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.

**Content**

Topics covered in lectures:

1. Environmental Regulation
   - Perspectives
   - Regulatory Challenges of Environment Problems
   - Regulatory Tools
2. Law: International, European and national laws
   - International law
   - European law
   - National law
3. Policy: Case studies

**Assessment:**

(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.

(ii) Exam (75%) consisting of three parts:
   - a. Policy brief - a maximum of 2 pages (including graphs and tables);
   - b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   - c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Data: 06.11.2018 12:57  
Autumn Semester 2016  
Page 634 of 1571
The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights). The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped

**Prerequisites / notice**

No specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0708-00 V) or an equivalent course.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

### 851-0738-00L Intellectual Property: Introduction

**Abstract**
The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights). Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.

**Objective**
The aim of this course is to enable students at ETH Zurich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.

Another goal is to enable the students to participate in the current debate over the goals and desirability of protecting intellectual creations, particularly in the areas of copyright (keywords: fair use, Creative Commons, Copyleft) and patent law (software patents, patent trolls, patent thickets).

### 851-0738-01L The Role of Intellectual Property in Daily Routine: A Practical Introduction

**Abstract**
The lecture gives an overview of the fundamental aspects of intellectual property, which plays an important role in the daily routine of engineers. The lecture aims to make participants aware of the various methods of protection and to put them in a position to use this knowledge in the workplace.

**Objective**
In recent years, knowledge about intellectual property has become increasingly important for engineers. Both in production and distribution and in research and development, engineers are increasingly being confronted with questions concerning the patenting of technical inventions and the use of patent information.

The lecture will acquaint students with practical aspects of intellectual property and enable them to use the acquired knowledge in their future professional life.

Topics covered during the lecture will include:
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups.

Case studies will illustrate and deepen the topics addressed during the lecture.

The seminar will comprise practical exercises on how to use and search patent information. Basic knowledge of how to read and evaluate patent documents as well as how to use publicly available patent databases to obtain the required patent information will also be provided.

**Prerequisites / notice**
The lecture is in particular tailored to the needs of the following degree programs: Agricultural science, architecture, civil engineering, computational science and engineering, computer science, electrical engineering and information technology, environmental engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-related degree programs, the lecture ‘Protecting inventions in chemistry’ (851-0738-03) will be offered in the autumn semester.

### 851-0738-03L Protecting Inventions in Chemistry

**Abstract**
The lecture gives students of chemistry-related degree programs an overview of the options to protect inventions and the underlying research efforts. The lecture aims to put the participants in a position to use this know-how in the workplace.
Objective

Research and development play an important role in chemistry-related technology sectors such as inorganic and organic chemistry or pharmacy.

Investments in the development of new substances and active components in these sectors are traditionally secured by patents because publicly known inventions, generally chemical substances, may easily be reproduced by others.

In the last years, the know-how about intellectual property has become increasingly important for chemists and engineers. Both in the production process and in the distribution sector, chemists and engineers are increasingly being confronted with questions concerning the patenting of technical inventions and the use of patent information. As more and more inventors of all kinds are working with chemically active substances and technical devices, the demand for patent information is growing.

The course of action to patent an invention is complicated by the fact that the same invention can be legally protected in different countries with different conditions and restrictions. The complexity of the field of patents is reflected in the different databases and the variety of search engines.

Patents are not only a powerful measure to protect investments and inventions in chemistry-related sectors but also an important source of information about competitors and potential cooperation partners and about the development of markets. Accordingly, the know-how about patents and patent information has become a key qualification on the strategic level in companies and in the research sector.

The seminar is customised to the needs of chemists and students of related degree programs. Participants will become familiar with practice-oriented aspects of intellectual property and will be enabled to use the acquired knowledge in their future professional life.

Topics covered during the lecture will include:
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects in day-to-day research, at the workplace and for the formation of start-ups
- Special aspects of protecting inventions in chemistry-related sectors, e.g. polymorphs and inventions in the field of nanotechnology.

Case studies will illustrate and deepen the topics addressed during the lecture.

The seminar will comprise practical exercises on how to use and search patent information. Basic knowledge of how to read and evaluate patent documents as well as how to use publicly available patent databases to obtain the required patent information will also be provided.

For engineering and physics students, the lecture 'The Role of Intellectual Property in daily routine: A Practical Introduction' (851-0738-01) will be offered in the autumn semester.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0743-01L</td>
<td>Law and Natural Resources</td>
<td>W</td>
<td>2</td>
<td>2V</td>
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</table>

This course teaches the possibilities and limits of the law in order to protect natural resources and landscapes against harm and nuisance.

The learning concept is based on the co-ordinated implementation of the relevant legislations. The complexity of the legal situation will be discussed by analysing virtual and real cases focused on spatial projects and planning.

Objective

The students know the opportunities and restrictions which are given by the law when using natural resources. They have insights into the complex environmental legal system and their application in concrete cases. The students are able to formulate typical legal questions, to understand the argumentation of courts and to solve simple legal problems with respect to environmental problems.

Content

The Studierenden werden eingeführt in die für die Nutzung natürlicher Ressourcen und die Gestaltung der Landschaft massgeblichen Rechtssysteme. Die als rechtsrelevant zu bewertenden Probleme und die daraus resultierenden Lösungsansätze sollen aufgezeigt werden.


Lecture notes

Den Studierenden werden Unterlagen wie eine Übersicht über die behandelten Stoffe auf PP-Folien, typische Gerichtsentscheide, Zeitungsartikel etc. über neue Vorhaben mit Auswirkungen auf die Umwelt und entsprechenden Rechtsfragen abgegeben.

Literature

Griffel, A.; Raumplanungs- und Baurecht in a nutshell, Dike Verlag, Zürich/St. Gallen 2012
Rausch/Marti/Griffel; Umweltrecht - Ein Lehrbuch. Herausgeber: Walter Haller. Schultess Verlag, Zürich 2004
Rausch, H.; Panorama des Umweltrechts - Kompendium der Umweltschutzvorschriften des Bundes, BUWAL-Schriftenreihe Umwelt Nr. 226, 4. A., Bern 2005
Keesl/Zimmermann; Bundesgerichtliche Rechtssprechung zur Waldgesetzgebung. In URP 2009/3
Weitere Literaturangaben erfolgen in der ersten Veranstaltung.

Prerequisites / notice

The course of action to patent an invention is complicated by the fact that the same invention can be legally protected in different countries with different conditions and restrictions. The complexity of the field of patents is reflected in the different databases and the variety of search engines.

For engineering and physics students, the lecture 'The Role of Intellectual Property in daily routine: A Practical Introduction' (851-0738-01) will be offered in the autumn semester.

Sociology

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0585-15L</td>
<td>Complexity and Global Systems Science</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>D. Helbing, N. Antulov-Fantulin</td>
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</tbody>
</table>

This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.

Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.
### Content
This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at “tipping points”, multi-stability, systemic instability, determinstic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or “tragedies of the commons” such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating technosocio-economic-environmental problems, and what data science may contribute to their solution.

### Prerequisites / notice
Mathematical skills can be helpful.

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Additional Credits</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their ideas in relation to behavioral science. The colloquium also features invited research talks.</td>
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<td><strong>Objective</strong></td>
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<td>Students know and can apply autonomously up-to-date investigation methods and techniques in the behavioral sciences. They achieve the ability to develop their own ideas in the field and to communicate their ideas in oral presentations and in written papers. The credits will be obtained by a written report of approximately 10 pages. The colloquium also serves as a venue for invited talks by researchers from other universities and institutions related to behavioral and social sciences.</td>
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<tr>
<th>Course Code</th>
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<th>Additional Credits</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td>851-0585-04L</td>
<td>Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>D. Helbing, L. Sanders, O. Wooley</td>
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<td></td>
<td><strong>Content</strong></td>
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<td>This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.</td>
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<tr>
<th>Course Code</th>
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<tr>
<td>851-0591-00L</td>
<td>Digital Sustainability in the Knowledge Society</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. M. Dapp</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g. Open Source/Content/Access. The course discusses consequences from different models and introduces “digital sustainability” as an alternative vision for society.</td>
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<td><strong>Objective</strong></td>
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<td>At the heart of the discussion is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of “intellectual property” and the industries based on it. Starting from economic and legal basics, we compare proprietary and open/“free” models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff. After the lecture, you should (hopefully) be able to</td>
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<td>- characterize the nature of digital goods vs. physical goods</td>
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<td>- critique the basic concepts of copyright and patent rights</td>
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<td>- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods</td>
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<td>- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society</td>
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<td>transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)</td>
</tr>
</tbody>
</table>

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 637 of 1571
Content
Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitalization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetics», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparable to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)...

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

More on teach.digisus.info starting from September. Stay tuned.

Lecture notes
Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

Literature
Content of the following books is covered (PDFs freely available online):
Other recommended books are:
1 (general) Chris DiBona et al., Open Sources: Voices from the Open Source Revolution, O'Reilly, 1999.

Prerequisites / notice
For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45. Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the lecture.

851-0588-00L
Introduction to Game Theory. Models and Experimental Studies

W 2 credits 2V A. Diekmann

Abstract
This course introduces the foundations of game theory. It focuses on models of social interaction, conflict and cooperation, the emergence of cooperation and concepts of strategic decision-making behaviour. Examples, applications and the contrast between theory and empirical results are particularly emphasized.

Objective
Learn the fundamentals, models, and logic of thinking about game theory.

Content
Apply game theory models to strategic interaction situations and critically assess game theory's capabilities through a wide array of experimental results.

More on teach.digisus.info starting from September. Stay tuned.

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 638 of 1571
Die folgenden Einführungen unterscheiden sich nach Anwendungen und Grad der Formalisierung. Zur Einführung kann man sich eines der folgenden Bücher ansehen, die ab Januar im Handapparat der D-GESS-Bibliothek stehen werden:


Weitere Literatur und Übungsaufgaben zum Download unter:
http://www.socio.ethz.ch/publications/spieltheorie

Um Missverständnisse zu vermeiden: Die Vorlesung ist für Hörerinnen und Hörer aller Departemente geeignet. (Nicht nur für D-MATL, D-MAVT)

851-0585-43L Experimental Game Theory Number of participants limited to 60

W 2 credits 2S A. Diekmann

Prerequisites / notice

The course addresses principles and methods of experimental game theory. It focuses on experiments about social interaction, conflict and cooperation, emergence of cooperation and experimental validity of concepts for strategic behaviour in decision-making situations.

Objective

Learn the fundamentals and logic of thinking about experimental methods and experimental game theory. Learn to read critically the scientific literature on experimental game theory. Apply experimental game theory methods to strategic interaction situations.

Content


Lecture notes

Folien der Spieltheorie-Vorlesung und Literatur (Fachartikel, Kapitel aus Lehrbüchern) können auf der Webseite des Seminars eingesehen und heruntergeladen werden.

Literature


(Ein Handapparat dieser und weiterer Literatur wird in der D-GESS-Bibliothek bereitgestellt.)

Literatur zum Download befindet sich auch auf der Webseite:
http://www.socio.ethz.ch/publications/spieltheorie

227-0802-02L Sociology

W 2 credits 2V A. Diekmann

Prerequisites / notice

Various studies are used to introduce basic sociological concepts, theories and empirical research methods, along with selected sociological topics. The goal of the course is to provide participants with an understanding of working practice in empirical sociology and the central findings of sociological studies.

Objective

To learn about methods of empirical social research and key results of classic and modern sociological studies.

Content

Sociologie befasst sich mit der Regelmäßigkeit sozialer Handlungen und ihrer gesellschaftlichen Folgen. Sie richtet ihren Blick auf die Beschreibung und Erklärung neuer gesellschaftlicher Entwicklungen und erfasst diese mit empirischen Forschungsmethoden. Die Vorlesung wird u.a. anhand von Beispielstudien - klassische Untersuchungen ebenso wie moderne Forschungsarbeiten - in die Grundbegriffe, Theorien, Forschungsmethoden und Themenbereiche der Soziologie einführen.

Folgende Themen werden behandelt:


3. Der Beitrag der Sozialtheorie. Vorstellung und Diskussion ausgewählter Studien zu einzelnen Themenbereichen, z.B.: (1) Die Entstehung sozialer Kooperation, (2) Reputation und Märkte, (3) Soziale Netzwerke u.a.m.


Literature

Folien der Vorlesung und weitere Materialien (Fachartikel, Kopien aus Büchern) werden auf der Webseite der Vorlesung zum Download zur Verfügung gestellt.

051-0811-00L Sociology I

W 1 credit 2V C. Schmid

Prerequisites / notice

Interesse am Thema und Bereitschaft zum Mitdenken.
Multivariate Methods

One of the lectures 701-1541-00 (autumn semester) OR 752-2110-00 (spring semester) are highly recommended for students in Environmental Sciences with the Major Environmental systems and Policy.

Abstract

The course teaches multivariate statistical methods such as linear regression, analysis of variance, cluster analysis, factor analysis and logistic regression.

Objective

Upon completion of this course, the student should have acquired:
1. Knowledge on the foundations of several methods of multivariate data analysis, along with the conditions under which their use is appropriate
2. Skill in the estimation, specification and diagnostics of the various models
3. Hands-on experience with those methods through the use of appropriate software and actual data sets in the PC lab

Content

The course will begin with an introduction to multivariate methods such as analysis of variance and multiple linear regression, where a metric dependent variable is "explained" by two or more independent variables. Then two methods for structuring complex data, cluster analysis and factor analysis will be covered. In the last part, procedures for the analysis of relationships involving dichotomous or polytomous dependent variables (e.g., the choice of a mode of transportation) will be discussed.

Literature

Will be announced at the beginning of the course.

Environmental Behavior in Social Context

Abstract

This introductory class in the environmental social sciences covers topics such as environmental behavior, environmental concern, social dilemmas and social norms.

Objective

Basic knowledge of the environmental social sciences
Overview on current fields of research and their relevance for practical application

Content


Fragen, die uns während des Semesters beschäftigen:
- Wie kommt es zu Umweltschädigungen, obwohl niemand diese beabsichtigt?
- Was verhält sich besonders umweltschonend? Wie wird dies gemessen?
- Welche Rolle spielt das Umweltbewusstsein?
- Welche Rolle spielen äussere Faktoren (Möglichkeiten, Kosten etc.)?
- Wie sehr lassen wir uns dadurch beeinflussen, was andere machen?
- Kooperieren wir nur, wenn auch andere dies tun?

Literature


Sociology: Urban Quality of Life - Ethnological Field

Research in District 5 and in Zurich North

Abstract

In this ethnographic field research we examine the question, how people are perceiving and creating their environment, and how an urban quality of life is forming. We investigate four neighborhoods in the Zurich Region: upper District 5, Zurich West, Seebach and Glattpark.

Objective

This elective course highlights the sociological perspective on architectural practice and provides an introduction to sociological research. It focuses on two main procedures: on the one hand, a systematic reading and discussion of theoretical texts, and on the other, empirical case studies of social aspects of the production of the built environment. In this course, a wide set of qualitative research methods is used (including various forms of interview, participant observation, image and text analyses). This approach enables students to gain their own experience by dealing with the various participants and constellations in the social field of architecture and building construction, and to familiarize themselves with the approaches and perceptions of various different participants.

Content

An introduction into ethnographic field research.

Urban ethnology concentrates on the urban space, on urban actors, on the citiescape and compares cities of different continents and cultures with each other. Urban ethnology investigates symbols and practices representing and participating in the normal course of city life. Urban ethnology understands urban space not only as built environment, but also as a lived cultural and social context. With ethnographic field research the perception of actors in local milieu is investigated. How do they see and experience urban contexts? How do they move in the city area? How do they recognize houses, roads and places? How do they hear the city? The perception of local milieu, their obstinacy, creativity and their special way of life is considered significant for better understanding the city as central point of current social development. For ethnographic surveys of the built environment architects nowadays use a number of methods and techniques: participating in observation, interviews, photo and video site inspections in urban rooms, mindmapping etc.

Special Topics in Cognitive Neuroscience

Abstract

Cognitive neuroscience bridges two seemingly distinct but closely related disciplines. On one side, there is cognitive psychology and on the other side biology, or more specifically, neuroscience. In terms of research, this relatively young field aims to explain such diverse mental processes as thinking, perceiving, feeling, and reasoning by exploring their underlying biological or neural mechanisms.

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 640 of 1571
Objective

This course explores selected topics of cognitive neuroscience. The course begins with a basic introduction to the field covering neural anatomy and brain physiology. Contemporary methods used in neuroscientific research (e.g., fMRI, EEG) will also be introduced and their benefits and limits critically reviewed. Using this knowledge, we will discuss some of the classic works in neuroscience in visual perception, memory and emotion. This will be accompanied by some famous cases of patients demonstrating problems in these domains (e.g., people with agnosia or amnesia). Further topics will include the cognitive and neural processes involved in pain processing, the placebo effect, as well as spatial representation and navigation.

This course targets students at the Bachelor level with no previous experience. The main requirement for this course is an open and critical mind. By the end of the course, the student will be able to identify the major brain structures and to explain the basic functioning of neurons as well as some of the fundamental principles of how our brain works. Students should have an understanding of the methods used to generate the various findings reported in the literature and the media. The course aims to enable and encourage the students to critically evaluate these findings, and what can and cannot be answered with neuroscience techniques. For each of the topics, students should be able to identify the phenomenon, give examples, and discuss one or two of the main theories explaining it.

851-0597-01L

Evolutionary Foundations of Social Behavior

W 2 credits 1V E. Voland

Abstract

This lecture will deal with the manifestations of the "selfish gene" principle in human social behavior. Cooperation and competition, selfishness and altruism, gender relations and parent-child conflicts are issues, the evolutionary backgrounds of which will be discussed. Special attention will be paid to the costly signaling theory.

Objective

You will receive an in-depth overview of the application of Darwinian theory on behavioral phenomena. This will enable you to approach the heuristic perspective of the so-called adaptationism program of social phenomena. Finally, you will be able to discern the benefits and the problems of the evolutionary perspective within various scientific disciplines, especially anthropology, psychology, empirical social research and comparative cultural sciences.

Literature


Prerequisites / notice


Science Research

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td>851-0157-00L</td>
<td>Mind and Brain</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Hagner</td>
</tr>
<tr>
<td>851-0157-66L</td>
<td>Who was Sigmund Freud?</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>M. Hagner</td>
</tr>
<tr>
<td>851-0157-67L</td>
<td>Creativity</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>M. Wulz, V. Wolff</td>
</tr>
<tr>
<td>851-0157-69L</td>
<td>History of Astronomy</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>S. Mastorakou</td>
</tr>
</tbody>
</table>

851-0157-00L

Mind and Brain

In the last 2500 years, the mind-brain relationship has been articulated in various ways. In these lectures, we will explore the scientific and philosophical aspects of this relationship in the context of relevant cultural, historical and technological processes, with a focus on the modern neurosciences, but I will also discuss works of art and literature.

Objective

By the end of this lecture, students should be familiar with essential positions in the scientific and philosophical treatment of questions relating the mind to the brain. It should also become clear that some of the most relevant problems in current neurosciences have a long history.

Content

According to a myth, the ancient Greek philosopher Democrit dissected animals, because he was in search of the seat of the soul. Current neuroscientists use neuroimaging techniques like functional magnetic-resonance-tomography in order to localize cognitive and emotional qualities in the brain. Between these two dates lies a history of 2500 years, in which the relationship between the mind and the brain has been defined in various ways. Starting with ancient and medieval theories, the lecture will have its focus on modern theories from the nineteenth century onward. I will discuss essential issues in the history of the neurosciences such as localization theories, the neuron doctrine, reflex theory, theories of emotions, neurocybernetics and the importance of visualizing the brain and its parts, but I will also include works of art and literature.

851-0157-66L

Who was Sigmund Freud?

This seminar is devoted to the introduction into the ideas and concepts of one of the most influential thinkers of the 20th century. We will read selected texts by Freud for getting an overview over his medical, psychological and cultural thinking.

Objective

30 years ago it would have been bizarre to ask the question: Who was Sigmund Freud? The influence of psychoanalysis on twentieth century thinking was taken for granted even by those who rejected Freud's ideas. In contrast, the question today would be: What are Freud's central theories? We will tackle this question in the seminar and reconstruct Freud's thinking from his early medical writings to those writings, in which he developed a critical view of a scientific aim. The aim of the seminar is not only to understand Freud's thinking in historical context, but also to reflect, what it could mean to us in early twentyfirst century.

851-0157-08L


Bruno Latour (* 1947) is one of the most important contemporary sociologist of science. He enriched our understanding of what a scientific discipline is and how we get to it, i.e. how it is made up, not only discovered. Latour defends a constructivist approach with realist elements. What that exactly means, will be clarified in this course.

Objective

- Introduction into the sociology of science of Bruno Latour, esp. the Agent/Network/Theory.
- Understanding main topics of sociology and philosophy of science.

851-0157-67L

Creativity

Number of participants limited to 40.

Abstract

Being creative may appear to be the most important requirement of the present age: creative thinking, start-ups, project development all seem to promise an ongoing innovation of work and life. Instead of repeating that promise once again, this course asks for the historical conditions of discourses of creativity.

Objective

We will deal with historical and contemporary theories of inventive imagination, fantasy, and creativity. Looking at artistic, psychological, pedagogical, economic, and entrepreneurial discourses of creativity from the 18th to the 21st century we will discuss their specific contexts in order to uncover historical differences and changes. Is it indeed possible to identify conjuctions between the economicization, scientification and normalization of creativity? Are there any alternatives to the reigning paradigm of creativity? And if so, what are those?
Die Veranstaltung ist ausgebucht

Abstract
The course is designed to provide an overview of the astronomical developments from the ancient Greek world to the 16th century. We are going to use primary sources tackling historical, technical and philosophical questions. Special attention will be paid to the dramatic change in the way people understood the structure of the heavens and the nature of the physical world.

Objective
The course aims at providing a working knowledge of astronomy and cosmology from the ancient world to the 16th century. Upon its completion the students will be able to describe how our knowledge of the heavens changed from Aristotle’s system to the Copernican Revolution. In addition, they will also have acquired an appreciation of the debates about man’s place in the cosmos and the philosophical principles underpinning cosmology.

851-0157-70L

The Mathematics of Scientific Racism

Abstract
How did racial scientists determine racial affiliation? In the seminar we will examine the practical challenges and eventual works of physical anthropologists from 1850 to the present. By scrutinizing the scientific toolbox of racial scientists, we will reveal how national affiliation, anti-Semitic perceptions and Gender identity shaped scholars’ choices of graphical and computational methods.

Objective
The aim of the course is to analyze the mutual relations between scientific theories and social perceptions, and to follow the formation of the “scientific mind”. The course focuses on racial scientists and on the way their practices of computation and statistical analysis influenced their world-views - and vice versa. The students will be instructed on the way historians of science analyze scientific sources. They will gain a better understanding of the complexities of disciplinary dynamics, social biases and institutional pressures shaping scientific ideas, and learn on the influences such scientific ideas may have on the society as a whole.

Prerequisites / notice
Please note that the seminar will be held in English and most texts will be in English. However, a small portion of the reading material will be in German.

701-0771-00L

Environmental Consciousness and Public Relations

Abstract
“Environmental Consciousness and Public Relations” shows how to communicate about environment and sustainability successfully. We look at campaigns, exhibitions and other public relations measures to learn, how to design and realize good communication.

Objective
You learn how to handle tools and concepts in environmental communication. And you can evaluate communication projects. We also discuss the evolution of consciousness.

Content
- Methods and tools in environmental communication.
- Marketing mix
- Examples of campaigns, events, print products, media relations.
- Integral sustainability

Lecture notes
Handouts
- Integral Vision; Ken Wilber, 2005

Prerequisites / notice
We will discuss new trends in environmental communication with the focus on integral solutions.

851-0158-07L

Worldviews in Conflict

Abstract
Worldviews guide our thoughts and our actions even though we may not be aware of it. They often are realized only when they are confronted with each other. By means of lectures, discussions and contributions of participants, we will examine those worldviews as to the underlying philosophical concepts and their relations to the sciences, philosophy and religion.

Objective
Students of all disciplines shall obtain a basis for their own exploration of worldviews. Prior knowledge of philosophical concepts and history is not required.

- **Type B: Reflection About Subject-Specific Methods and Contents**
  
  Subject-specific courses: Recommended for doctoral, master and bachelor students (after first-year examination only).

  Students who already took a course within their main study program are NOT allowed to take the course again.

  These course units are also listed under "Type A", which basically means all students can enroll

- **D-ARCH**

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<tr>
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<td>851-0724-00L</td>
<td>Property Law for Geometers: Land Registry and Geoinformation Law</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Huser</td>
</tr>
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Abstract
Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).

Objective
Overview of the legal norms of land registry and surveying law.

Content
Basic principles of material and formal land registry law, components of the land register, consequences of the land register, the registration process, legal problems of surveying, the reform of official surveying, liability of the geom-eter. The lecture unit is carried out within a frame of 8 sessions (2 hours): the first hour of each is given in the form of a lecture, the second in the form of a case-study.

Lecture notes
Abgegebene Unterlagen: Skript in digitaler Form

Literature
- Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014
- Meinrad Huser, Geo-Informationsrecht, Rechtlicher Rahmen für Geographische Informationssysteme, Zürich 2005
- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBGR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

Prerequisites / notice
Requirements: Property Law (12-722)
Environmental Law: Topics and Case Studies  
851-0705-02L 

Prerequisites: Environmental Law: Conceptions and Fields (851-0705-01L) offered in spring semester.

Number of participants limited to 20.

Objectives: This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical

Abstract: The aim of this workshop is to equip students with legal skills and methods to solve or treat problems and questions of the environmental law and foster the understanding on the possibilities and limits of legal problem-solving. The students choose an inquiry with practical relevance. To this end they work out the legal basis demonstrating a legal correct solution or approach to a solution. In doing so, students will get to know legal methods and research possibilities.

Content: At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional QA-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a maximum of ten pages (including graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

Lecture notes: Den Studierenden werden Unterlagen zur juristischen Methoden- und Quellenlehre sowie zum Inhalt und Ablauf des Kurses zu Beginn der Veranstaltung kostenlos abgegeben.

Literature: Rechtsgrundlagen, Literatur und Gerichtsentscheide werden themenspezifisch selber recherchiert, unter Mithilfe und Beratung des Dozenten.

Prerequisites / notice: Die Veranstaltung erfordert die Bereitschaft, sich aktiv und selbständig mit einer selbstgewählten Fragestellung oder einem eigenen Fallbeispiel aus dem Gebiet des Umweltrecht und allenfalls aus Schnittstellengebieten auseinanderzusetzen. Damit die Interaktivität und die Leitung des Teams gewährleistet werden kann, ist die Teilnehmerzahl auf maximal 16 Personen beschränkt. Es handelt sich um eine Vertiefungsveranstaltung. Der Besuch der Vorlesung "Umweltrecht: Konzepte und Rechtsgebiete" (851-0705-01) ist Voraussetzung.

Space Planning Law and Environment  
851-0707-00L 

Abstract: System of swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, Instruments, Application, legal protection, enforcement, Practical training.

Objective: Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.


Human-Computer Interaction: Cognition and Usability  
851-0252-01L 

Number of participants limited to 30.

Objectives: This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects.

Abstract: This seminar introduces key topics, theories and methodology in computer-human interaction (HCI) and usability. Presentations will cover basics of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that first familiarize themselves with a select usability evaluation method (e.g. user testing, GOMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the plenary. Active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay / report will be required (details to be specified in the introductory session of the course).

Cognition in Architecture - Designing Orientation and Navigation for Building Users  
851-0252-03L 

Number of participants limited to 40.

Abstract: How can behavioral and cognitive science inform architecture? This project-oriented seminar investigates contributions of cognitive science to architectural design with an emphasis on orientation and navigation in complex buildings and urban settings. It includes theories on spatial memory and decision-making as well as hands-on observations of behavior in real and virtual reality.

Objective: Taking the perspectives of building users (occupants and visitors) is vital for a human-centered design approach. Students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to understand human behavior in built environments. The foundations of environmental psychology and human spatial cognition will be introduced. A focus of the seminar will be on how people perceive their surroundings, how they orient in a building, how they memorize the environment and how they find their way from A to B. Students will also learn about a range of methods including real-world observation, virtual reality experiments, eye-tracking and behavior simulation for design. Students will reflect on the roles of designers and other stakeholders with respect to human-centered design and an evidence-based design perspective. The seminar is geared towards a mix of students from architecture / planning, engineering, computer science and behavioral science as well as anybody interested in the relation between design and cognition. Architecture students can obtain course credit in "Vertiefungsfach" or "Wahlfach".

Postal Knowledge and the History of Digital Societies  
851-0551-03L
### D-BAUG

**851-0738-01L** Philosophy of the Environmental Sciences: An Introduction  
**W** 3 credits 2S A. Schwarz

**Abstract**  
Environmental knowledge and management is quite common in different common fields and in everyday practice. We will be identifying those concepts, objects and methods that mainly construe what might be called the core of the environmental sciences. This will be done by using different philosophical tools and approaches.

**Objective**  
The environmental sciences cover a wide range of scientific practices and objects and accordingly afford different kinds of scientific knowledge. Additionally, there is an important interplay between the scientific and the societal sphere. In this seminar we will examine likewise central and widespread concepts such as sustainable development or resilience by using philosophical tools that will allow to probe the different uses of those concepts, their semantic range in terms of historical depth and semantic fields and finally their logical coherence. Another important topic is the philosophical investigation of methods and objects that can be identified in the environmental sciences. Those methods are for instance Life Cycle Assessment or Adaptive Ecosystem Management, technological objects may be a wind engine or a hydropower plant. The latter raise questions of how renewable energies can be assessed and evaluated, including the more general issue of how values and norms can be embedded in technological objects. This leads us to the third and last complex of topics that focus on current deliberations about possible new ways of existence in the age of the Anthropocene and as a consequence the formation of adequate life styles in our societies.

This refers to issues in philosophical and social anthropology and the challenge of climate change.

### Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
851-0738-01L | The Role of Intellectual Property in Daily Routine: A Practical Introduction | W | 2 | 2V | C. Soltmann

**Abstract**  
The lecture gives an overview of the fundamental aspects of intellectual property, which plays an important role in the daily routine of engineers. The lecture aims to make participants aware of the various methods of protection and to put them in a position to use this knowledge in the workplace.

**Objective**  
In recent years, knowledge about intellectual property has become increasingly important for engineers. Both in production and distribution and in research and development, engineers are increasingly being confronted with questions concerning the patenting of technical inventions and the use of patent information.

The lecture will acquaint students with practical aspects of intellectual property and enable them to use the acquired knowledge in their future professional life.

- Topics covered during the lecture will include:
  - The importance of innovation in industrialised countries
  - An overview of the different forms of intellectual property
  - The protection of technical inventions and how to safeguard their commercialisation
  - Patents as a source of technical and business information
  - Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups.

Case studies will illustrate and deepen the topics addressed during the lecture.

**Prerequisites / notice**  
The seminar will comprise practical exercises on how to use and search patent information. Basic knowledge of how to read and evaluate patent documents as well as how to use publicly available patent databases to obtain the required patent information will also be provided.

The lecture is particular tailored to the needs of the following degree programs: Agricultural science, architecture, civil engineering, computational science and engineering, computer science, electrical engineering and information technology, environmental engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-related degree programs, the lecture ‘Protecting inventions in chemistry’ (851-0738-03) will be offered in the autumn semester.

**851-0724-00L** Property Law for Geometers: Land Registry and Geoinformation Law  
**W** 2 credits 2V M. Huser

**Abstract**  
Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).

**Objective**  
Overview of the legal norms of land registry and surveying law.

**Content**  
Basic principles of material and formal land registry law, components of the land register, consequences of the land register, the registration process, legal problems of surveying, the reform of official surveying, liability of the geom-eter. The lecture unit is carried out within a frame of 8 sessions (2 hours): the first hour of each is given in the form of a lecture, the second in the form of a case-study.

**Lecture notes**  
Abgegebene Unterlagen: Skript in digitaler Form

Pflichtlektüre: Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014.
WebClass Introductory Course History of Technology

851-0705-00L

WebClass Introductory Course History of Technology

Number of participants limited to 100.

Particularly suitable for students of D-BAUG, D-INFK, D-ITET, D-MATL, D-MAVT.

WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Objective

Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get to know basic theories and practices of the field.

Content


Literature

- Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrecht und des Grundbuchrechts, Zürich 2014
- Meinrad Huser, Geo-Informationsrecht, Rechtlicher Rahmen für Geographische Informationssysteme, Zürich 2005
- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBGR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

Prerequisites / notice

Requirements: Property Law (12-722)
Postal Knowledge and the History of Digital Societies  
W  3 credits  2S  D. F. Zetti

Abstract
In the second half of the 20th century, postal services have dramatically changed. Communication today is computer-based. The lecture offers problem-oriented insights into this sociotechnical process of translation.

Objective
Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication.

Content

Prerequisites / notice
The procedure for accumulating CP will be explained at the start of term.

History of Urban Design I  
W  2 credits  2G  V. Magnago Lampugnani

Abstract
The lecture covers the time from the beginning of urban culture until the mid 19th century. With selected examples it emphasizes on the historical planning and methods of European cities. Each specific urban development will be presented within a broader context.

Objective
This course analyzes the history of urban architecture primarily in its existing three dimensional form as a complex human artefact. It also explores the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.

Content
In the first semester an introduction to the discipline and the methods are given along the thematic issues from the beginning of urban culture until the mid-19th century.

01. Introduction to the discipline and method: The history of urban design as a historical project
02. Athens and Rome in the ancient world: Myth, self-portrayal and speculation
03. From the spirit of equality to the colonial module: Greek and Roman City foundings
04. From the urban ideal to new cities in the Middle Ages and the Renaissance
05. Baroque strategies: The new organisation of Rome under Sixtus V, the production of Versailles under Louis XIV and the invention of St. Petersburg
06. The city between Absolutism and Enlightenment: baroque defence-designs, the European colonization of the American continent and the reconstruction of Lisbon
07. Ideology and speculation after the Glorious Revolution: landscapgegardens and urban figurations in England from 1650-1850
08. Between modernization, Grandeur and repression: Embellishment in Paris from 1750-1830
09. The construction of the bourgeois city: Georges-Eugène Haussmann transforms Paris into the capital of the 19th century
10. Architectural insertion and plan for the expansion of the city: From the Berlin of Karl Friedrich Schinkel to James Hobrecht
11. Neoabsolute power, bourgeois self-confidence and Marxian Idealism: The Viennese Ringstrasse and Ildenfons Cerdas Ensanche for Barcelona

Lecture notes
The lectures are accompanied by a script (two semesters of the bachelor studies), that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 30.-. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note.

Literature
Further recommended literature to consult is listet within the script.

Environmental Ethics  
W  2 credits  2V  M. Huppenbauer

Abstract
The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

Objective
On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and argumentsation that will be found within the field of environmental ethics and will have practised these in small case studies.

Content
- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Students topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

Lecture notes
Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.

Literature
In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfundung. Ein Handbuch für die Praxis, 2nd Edition Zürich 2014

Generel introductions:
- Marcus Düwell et. al (Hrsg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et. al (Hrsg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Prerequisites / notice
The procedure for accumulating CP will be explained at the start of term. You are expected to participate and contribute to discussions, keep the course interesting and lively.
Abstract
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical software Stata.

Objective
Students
- have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software STATA for data analysis

Content
The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.

D-BIOL

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<tr>
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<tbody>
<tr>
<td>851-0180-00L</td>
<td>Research Ethics</td>
<td>W</td>
<td>2</td>
<td>G</td>
<td>G. Achermann</td>
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Abstract
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective
The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry
---------------------------------------
Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
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Moral reasoning I: Arguments
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Moral reasoning II: Decision-making
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- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)
----------------------------------------------------------
Integrity in Research & Research Misconduct
- What is “integrity” in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
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Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

851-0144-19L Philosophy of Time 3 credits 2V N. Sieroka
Particularly suitable for students of D-BIOL, D-INFK, D-MATH, D-PHYS

Abstract
This course provides an introduction to philosophical issues surrounding the concept of time. We will treat topics such as: the existence of past, present, and future; the possibility of time travel; the constitution of time consciousness and its possible neurophysiological counterparts; temporal biases in the conduct of our lives; responsibility to future and past generations.
By the end of the course students are able to describe and compare different theories and concepts of time (physical time, perceptual time, historical time ...). They are able to identify and examine issues concerning time as they occur in various philosophical subdisciplines - especially in philosophy of science, philosophy of mind, metaphysics, and ethics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific and social contexts.

Part of the course reflects on methods and contents from physics, neuroscience/cognitive science, and logic.

851-0101-53L
Collections in Context: What Do Historians and Scientists Learn from Butterflies, Stones, and Bones?

**Objective**
Zurich holds huge scientific collections. They contain objects from around the world, some of them dating back to the 18th century. This interdisciplinary seminar combines perspectives from the history of science and from current scientific disciplines. What do these objects tell us about Zurich's place in the global history of science? What potentials do old collections hold for scientists today?

**Abstract**
The aim of this seminar is threefold: Firstly, students will become familiarised with historiographical approaches to scientific collections. Among them are constructivist approaches that seek to understand scientific knowledge not primarily as a system of objective truths, but rather as an outcome of human 'constructions'. Other approaches deal with the problem of how scientific objects are related to systems of power and oppression, namely in the case of objects collected during the time of European colonialism overseas. Secondly, students will become familiarized with how old collections can yield new insights for current scientists working, e.g., on questions of ecology. Thirdly, the seminar shall serve as a platform to discuss ways of dialogue and possible collaboration between these different approaches.

Students will be expected to read theoretical texts and case studies during semester, participate in discussions with external experts (historians, curators, and scientists), and to write a summarizing essay at the end of the term.

### D-BSSE

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<thead>
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<tr>
<td>851-0125-58L</td>
<td>Philosophy of the Environmental Sciences: An Introduction</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>A. Schwarz</td>
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</table>

**Objective**
The environmental sciences cover a wide range of scientific practices and objects and accordingly afford different kinds of scientific knowledge. Additionally, there is an important interplay between the scientific and the societal sphere. In this seminar we will examine likewise central and widespread concepts such as sustainable development or resilience by using philosophical tools that will allow to probe the different uses of those concepts, their semantic range in terms of historical depth and semantic fields and finally their logical coherence. Another important topic is the philosophical investigation of methods and objects that can be identified in the environmental sciences. Those methods are for instance Life Cycle Assessment or Adaptive Ecosystem Management, technological objects may be a wind engine or a hydropower plant. The latter raise questions of how renewable energies can be assessed and valued, including the more general issue of how values and norms can be embedded in technological objects. This leads us to the third and last complex of topics that focus on current deliberations about possible new ways of existence in the age of the Anthropocene and as a consequence the formation of adequate life styles in our societies. This refers to issues in philosophical and social anthropology and the challenge of climate change.

851-0101-53L
Collections in Context: What Do Historians and Scientists Learn from Butterflies, Stones, and Bones?

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<td>2S</td>
<td>B. Schär, M. Greeff</td>
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### D-CHAB

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<tbody>
<tr>
<td>851-0738-03L</td>
<td>Protecting Inventions in Chemistry</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>C. Soltmann</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture gives students of chemistry-related degree programs an overview of the options to protect inventions and the underlying research efforts. The lecture aims to put the participants in a position to use this know-how in the workplace.
Objective

Research and development play an important role in chemistry-related technology sectors such as inorganic and organic chemistry or pharmacy.

Investments in the development of new substances and active components in these sectors are traditionally secured by patents because publicly known inventions, generally chemical substances, may easily be reproduced by others.

In the last years, the know-how about intellectual property has become increasingly important for chemists and engineers. Both in the production process and in the distribution sector, chemists and engineers are increasingly being confronted with questions concerning the patenting of technical inventions and the use of patent information. As more than three-quarters of all publicly available technical information are available only in patents, it is more and more important for researchers and engineers to be capable of extracting relevant information from the flood of patents.

Patents are not only a powerful measure to protect investments and inventions in chemistry-related sectors but also an important source of information about competitors and potential cooperation partners and about the development of markets. Accordingly, the know-how about patents and patent information has become a key qualification on the strategic level in companies and in the research sector.

The seminar is customised to the needs of chemists and students of related degree programs. Participants will become familiar with practice-oriented aspects of intellectual property and will be enabled to use the acquired knowledge in their future professional life.

Topics covered during the lecture will include:
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups
- Special aspects of protecting inventions in chemistry-related sectors, e.g. polymorphs and inventions in the field of nanotechnology.

Case studies will illustrate and deepen the topics addressed during the lecture.

Prerequisites / notice

The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, biotechnology, chemical engineering, chemistry, food science, pharmaceutical sciences.

For engineering and physics students, the lecture 'The Role of Intellectual Property in daily routine: A Practical Introduction' (851-0738-01) will be offered in the autumn semester.

851-0180-00L Research Ethics

Particularly suitable for students of D-BIOL, D-CHAB, D-HEST

Abstract

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective

The main goal of this course is to enhance the student’s ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
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- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
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II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is “integrity” in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
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Authorship & Peer review
- Criteria for authorship;
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- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

Number of participants limited to 20.

Science, Technology, and Policy MSc and MAS in Development and Cooperation have priority.
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.

Objective

Students
- have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software STATA for data Analysis

Content

The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.

851-0144-20L

Philosophical Aspects of Quantum Physics

W 3 credits

Objective

Familiarisation with various basic standpoints within environmental ethics.
Overview and discussion of ethical theories relevant to the environment.
Develop a critical understanding of these different interpretations and issues concerning the transition between quantum and classical descriptions in physics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific contexts.

Abstract

This course provides an introduction to philosophical issues surrounding quantum physics. In particular, we will examine different interpretations of quantum mechanics (such as the many-world interpretation) and the transition between the quantum and the classical physical realm (here phenomena such as decoherence will be highlighted).

851-0125-58L

Philosophy of the Environmental Sciences: An Introduction

W 3 credits

Objective

By the end of the course students are able to describe and compare different interpretations of quantum mechanics. They are able to identify and examine issues concerning these different interpretations and issues concerning the transition between quantum and classical descriptions in physics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific contexts.

Abstract

The course provides an introduction to philosophical issues surrounding quantum physics. In particular, we will examine different interpretations of quantum mechanics (such as the many-world interpretation) and the transition between the quantum and the classical physical realm (here phenomena such as decoherence will be highlighted).

851-0125-51L

Man and Machine

W 3 credits

Objective

On the one hand models of machines had a heuristic value in research on man, e.g. in Harvey’s discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these models were always criticised, sometimes polemically, because important here: the clockwork, the steam engine and the computer.

Abstract

The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different models of machines will be going to use primary sources tackling historical, technical and philosophical questions. Special attention will be paid to the dramatic change in the way people understood the structure of the heavens and the nature of the physical world.

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Lecture notes

Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.

In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, 2nd Edition Zürich 2014

Literature

- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O’Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethism ausserhumanen Bereich, Paderborn (mentis) 2008

General introductions:

- Marcus Düwell et. al (Hrg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et. al (Hrg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Prerequisites / notice

The procedure for accumulating CP will be explained at the start of term.

I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.


Science, Technology, and Policy MSc and MAS in Development and Cooperation have priority.

Abstract

This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.

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D-HEST

851-0125-51L Man and Machine  ■  W  3 credits  2G  M. Hampe

Abstract

The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different modells of machines will be important here: the clockwork, the steam engine and the computer.

Objective

On the one hand modells of machines had a heuristical value in research on man, e.g. in Harvey's discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these modelss were always criticised, sometimes polemically, because they are supposedly not adequate for man. Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

851-0180-00L Research Ethics  ■  W  2 credits  2G  G. Achermann

Abstract

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective

The main goal of this course is to enhance the student's ability to:
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Lecture notes
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Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

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Abstract
In the second half of the 20th century, postal services have dramatically changed. Communication today is computerbased. The lecture offers problem oriented insights into this sociotechnical process of translation.

Objective
Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication.
Die Palette postalischer Produkte, Dienstleistungen und Personalien ist spannend und vielfältig. (Liebes-)Briefe und Geldsendungen, Boten

Introduction to Health Economics and Policy  
- W 3 credits  2V  W. Milmra

Abstract
Health expenditures constitute about 10% of GDP in OECD countries. Extensive government intervention is a typical feature in health markets. Risk factors to health have been changing with growing importance of lifestyle factors such as smoking, obesity and lack of physical activity. This course gives an introduction to the economic concepts and empirical findings in health economics.

Objective
Introduce students without prior economics background to the main concepts of health economics and policy to enhance students understanding of how health care institutions and markets function.

Content
The course gives an introduction to the economic concepts and empirical findings in health economics to enhance students understanding of how health care institutions and markets function. First, the three important decisions made by individuals will be analyzed: What determines the health behaviors, like the intensity of preventive measures like sport, that an individual undertakes? What types and amount of personal health care services does an individual demand? How much health insurance coverage will be purchased?

In a second part, the major participants on the supply side of health care markets - physicians, hospitals, nurses and pharmaceutical manufacturers - will be discussed. E.g., how important are financial incentives in the choice of medicine as a career, specialty choice and practice location? What does it mean and imply that a physician is an agent for a patient? How do pharmaceutical firms decide on investments in new products and how can public policy encourage pharmaceutical innovation?

The choices made by societies about how health care services are financed and about the types of organizations that supply health care will be addressed in a third part. One important choice is whether a country will rely on public financing of personal health care services or encourage private health insurance markets. How could and should a public health insurance system be designed? What health care services should be included or excluded from a public system? Another important choice is whether a society relies on government provision of health care services, private provision by not-for-profit or for-profit organizations or some combination. The advantages and disadvantages of the alternatives will be discussed to provide a framework for analyzing specific types of health care systems.

Literature

860-0006-00L  Applied Statistics and Policy Evaluation  
- W 3 credits  3G  I. Günther, K. Hartgen

Abstract
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.

Objective
Students
- have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
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- are able to use the statistical software STATA for data Analysis

Content
The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.

D-INFK

Number  Title  Type  ECTS  Hours  Lecturers
851-0252-01L  Human-Computer Interaction: Cognition and Usability  
- W 3 credits  2S  I. Barisic, C. Hölscher, S. Ognjanovic

Abstract
This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects.

Objective
This seminar will introduce key topics, theories and methodology in human-computer interaction (HCI) and usability. Presentations will cover basics of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that familiarize themselves with a selected usability evaluation method (e.g. user testing, GOMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the plenary. Active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay / report will be required (details to be specified in the introductory session of the course).

851-0727-02L  E-Business-Law  
- W 2 credits  2V  D. Rosenthal

Abstract
The course deals with the basic legal framework for doing e-business as well as using information technology. It discusses a variety of legal concepts and rules to be taken into account in practice, be it when designing and planning new business models, be it when implementing online projects and undertaking information technology activities.

Objective
The objective is knowing and understanding key legal concepts relevant for doing e-business, in particularly understanding how e-business is regulated by law nationally and internationally, how contracts are concluded and performed electronically, which rules have to be obeyed in particular in the Internet with regard to third party and own content and client data, the concept of liability applied in e-business and the role of the law in the practical implementation and operation of e-business applications.
Es wird mit Folien gearbeitet, die als PDF über die elektronische Dokumentenablage (ILIAS) auf dem System der ETHZ vorgängig abrufbar sind. Auf dem Termin- und Themenplan (ebenfalls online abrufbar) sind Links zu Gesetzesexternen und weiteren Unterlagen abrufbar. Schliesslich wird jede Vorlesung auch als Podcast aufgezeichnet, der jedoch nur für die Studierenden mit einem Passwort (erhältlich beim Dozenten) zugänglich sind.

Die Semesterendprüfung ist in Form eines schriftlichen Kurztjestes (normalerweise MC) in voraussichtlich der letzten Doppelstunde geplant. Es wird angegeben, welche Unterlagen beim jeweiligen Thema den Prüfungsstoff definieren. Der Test wird möglicherweise elektronisch durchgeführt.

Ferner bietet Ursula Widmer eine Vorlesung zum Thema Informationssicherheit an, welche die rechtlichen Aspekte der Sicherheit von ICT-Infrastrukturen und Netzen und der transportierten und verarbeiteten Informationen.

**851-0591-00L Digital Sustainability in the Knowledge Society**

**Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS.**

**Abstract**

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g., Open Source/Content/Access. The course discusses consequences from different models and introduces «digital sustainability» as an alternative vision for society.

**Objective**

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open"free" models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff. After the lecture, you should (hopefully) be able to:

- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

**Content**

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?» The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of "intellectual property", which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetic», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can dictate technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge. Comparable to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)...

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2010.ethz.ch. More on teach.digisus.info starting from September. Stay tuned.

**Lecture notes**

Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.
Material for the lecture slides will be presented on the course webpage after each lecture.

3 credits
2V
D. F. Zetti

Students become familiar with the mutual interdependence of social and technological change that characterizes the history of computing. 

For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45. Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the lecture.

851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB

Number of participants limited to 70.

Content
This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g., models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Literature

Prerequisites / notice
The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

851-0549-00L WebClass Introductory Course History of Technology

Number of participants limited to 100.

Content
WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

Prerequisites / notice
The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

851-0551-03L Postal Knowledge and the History of Digital Societies


Content

Weitere Informationen unter https://www.tg.ethz.ch/de/programme/
Objective By the end of the course students are able to describe and compare different theories and concepts of time (physical time, perceptual time, historical time ...). They are able to identify and examine issues concerning time as they occur in various philosophical subdisciplines - especially in philosophy of science, philosophy of mind, metaphysics, and ethics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific and social contexts.

851-0144-21L Philosophical Issues and Problems in Theoretical Computer Science

Abstract This course studies philosophical issues concerning computers and computing. Topics include: information (and information content), computational complexity, the Turing Test for computer thought; the "Chinese Room" argument against the possibility of strong AI; connectionist AI; consciousness; the Church-Turing thesis; computational and hypercomputational models of mind; and free will.

Objective - Exhibit a general understanding of the philosophy and history of computing.
- Explain central problems in the field and their potential solutions, independently and at a level requiring in-depth knowledge and critical understanding.
- Communicate clearly in writing about topics in this field.

851-0144-22L Developments in Logic after Gödel: Applications to Theoretical Computer Science

Abstract The course will start by presenting a modern logic, namely (propositional) modal logic, which has turned out to be extremely fruitful and to have numerous interesting applications in computer science, mathematics and philosophy. Subsequently, two of these applications to computer science, tense logic and dynamic logic, and one application to mathematics, provability logic, will be introduced.

Objective - Learn the fundamental concepts of a range of propositional logics
- Learn how to construct proofs in these logics
- Study the interface between mathematical logic and computer science, and mathematical logic and mathematics

860-0006-00L Applied Statistics and Policy Evaluation

Abstract This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.

Objective - Students have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software STATA for data Analysis

Content The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercise session.

D-ITET

Number Title Type ECTS Hours Lecturers
851-0591-00L Digital Sustainability in the Knowledge Society

Abstract How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g. Open Source/Content/Access. The course discusses consequences from different models and introduces «digital sustainability» as an alternative vision for society.

Objective At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open "free" models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff. After the lecture, you should (hopefully) be able to
- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- use an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)
Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate way anymore, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetics», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparable to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)... As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

More on teach.digisus.info starting from September. Stay tuned.
851-0252-01L  Human-Computer Interaction: Cognition and Usability  W  3 credits  2S  I. Barisic, C. Hölscher, S. Ognjanovic

Abstract
This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects.

Objective
This seminar will introduce key topics, theories and methodology in human-computer interaction (HCI) and usability. Presentations will cover basics of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that first familiarize themselves with a select usability evaluation method (e.g. user testing, GOMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the plenary. Active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay / report will be required (details to be specified in the introductory session of the course).

851-0585-04L  Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB  W  3 credits  2S  D. Helbing, L. Sanders, O. Woolley

Abstract
This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Objective
Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Prerequisites / notice
Number of participants limited to 70.

Literature

Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

851-0549-00L  WebClass Introductory Course History of Technology  W  3 credits  2V  G. Hürlimann

Abstract
WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Objective
Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get to know basic theories and practices of the field.

Content

Lecture notes

Prerequisites / notice

Weitere Informationen unter https://www.tg.ethz.ch/de/programme/

851-0735-10L  Business Law  W  2 credits  2V  P. Peyrot

Abstract
The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.
The students shall obtain the following competence:
- They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise.
- They shall be acquainted with corporate functions as contracting, negotiation, claims management and dispute resolution
- They shall be familiar with the issues of corporate compliance, i.e. the system to ascertain that all legal and ethical rules are observed.
- They shall be able to contribute to the legal management of the company and to discuss legal issues.
- They shall have an understanding of the law as a part of the corporate strategy and as a valuable resource to the company.

Lecture notes
A comprehensive script will be made available online on the moodle platform.

851-0594-00L International Environmental Politics W 3 credits 2V T. Bernauer

Abstract
This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

Objective
The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

Content
This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of transboundary water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory.

Lecture notes
Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike.Hudecheck@student.ethz.ch). All assigned papers must be read ahead of the respective meeting. Following the course on the basis of on-line slides and papers alone is not sufficient. Physical presence in the classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GESS library at the IFW building, Haldeneggstrasse 4, B-floor, or in the library of D-USYS.

Literature
Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike.Hudecheck@student.ethz.ch).
The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights). Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.

Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

This course deals with complex technosocio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.

This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at “tipping points”, multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or “tragedies of the commons” such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating technosocio-economic-environmental problems, and what data science may contribute to their solution.

Mathematical skills can be helpful.

This course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights). Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.
The lecture series "Images of Mathematics" deals with the formalization of the objects and the logical language of mathematics from Hilbert to Gödel and considers its consequences in view of our conception of mathematical practice and knowledge, the limits of calculability and computability in mathematics, and the relation between the logical proof procedures and the involved intuitive aspects. Moreover, Gödel’s theorems open many far-reaching and intriguing questions in view of our image of mathematics, questions concerning the conception of mathematical practice and knowledge, the limits of calculability and mathematics and the possible role of computability and machines in mathematics, the relation between the logical proof procedures and the involved intuitive aspects. In short, the image of mathematics is not as static as we sometimes expect it to be, it was radically redrawn by the mathematicians of the 20th century and has since then again been open to diverging interpretations.

Literature

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<tr>
<th>Number</th>
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<td>851-0125-41L</td>
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<td>W</td>
<td>3</td>
<td>2V</td>
<td>O. Müller</td>
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<td>851-0549-00L</td>
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Data: 06.11.2018 12:57  Autumn Semester 2016  Page 663 of 1571
Die Spieltheorie stellt Modelle zur Beschreibung und Analyse sozialer Interaktionen zur Verfügung. Klassische Probleme wie die

This course introduces the foundations of game theory. It focuses on models of social interaction, conflict and cooperation, the emergence of cooperation and concepts of strategic decision-making behaviour. Examples, applications and the contrast between theory and empirical results are particularly emphasized.

Objective


Content


Lecture notes

In der Vorlesung wird Wert darauf gelegt, Modelle an Beispielen zu demonstrieren und empirische Untersuchungen ("experimentelle Spieltheorie") vorzustellen.

Literature

Die folgenden Einführungen unterscheiden sich nach Anwendungen und Grad der Formalisierung. Zur Einführung kann man sich eines der folgenden Bücher ansehen, die ab Januar im Handapparat der D-GESS-Bibliothek stehen werden:


Weitere Literatur und Übungsaufgaben zum Download unter:

http://www.socio.ethz.ch/publications/spieltheorie

Prerequisites / notice

Um Missverständnisse zu vermeiden: Die Vorlesung ist für Hörerinnen und Hörer aller Departemente geeignet. (Nicht nur für D-MATL, D-MAYT).

851-0588-00L

Introduction to Game Theory. Models and Experimental Studies

Particularly suitable for students of D-MAVT, D-MATL

W 2 credits 2V A. Diekmann

Abstract

This course introduces the foundations of game theory. It focuses on models of social interaction, conflict and cooperation, the emergence of cooperation and concepts of strategic decision-making behaviour. Examples, applications and the contrast between theory and empirical results are particularly emphasized.

Objective


Content


Lecture notes


Literature

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851-0591-00L

Digital Sustainability in the Knowledge Society

Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS.

W 2 credits 2V M. M. Dapp

Abstract

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g. Open Source/Content/Access. The course discusses consequences from different models and introduces «digital sustainability» as an alternative vision for society.

Objective

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling information in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Strong intellectual property rights are contrasted with open models like, e.g. Open Source/Content/Access. The course discusses the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods.

- critique the nature of digital goods vs. physical goods
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)
Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate way, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetics», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

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More on teach.digisus.info starting from September. Stay tuned.

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

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More on teach.digisus.info starting from September. Stay tuned.
Objective: By the end of the semester, participants should have a solid knowledge of the history and theoretical foundations of International Relations.

Abstract: This course provides an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.

Objective: By the end of the semester, participants should have a solid knowledge of the history and theoretical foundations of International Relations since the end of the Second World War.

Content: The aim of the course is to provide participants with an overview of international security politics with a special focus on dual-use technologies. Students will analyze the character of dual-use security risks and of risk-based security strategies and instruments. Thematic areas include the nuclear non-proliferation regime, biological and chemical weapons conventions, missile proliferation, the nuclear programs of Iran and North Korea, cyber and space technologies, as well as robotics and nanotechnology.

Literature: Participants are expected to study the compulsory texts provided at the beginning of the semester via the online platform Moodle.

Prerequisites / notice: A reading list will be distributed at the beginning of the semester.

701-0791-00L

Objective: Environmental History: An Introduction and Overview

Abstract: The lecture begins with an introduction to environmental history; the lecture serves as an introduction to general and applied ethics. We shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, 2nd Edition Zürich 2014

Objective: Students are asked to write an exam during the second last session (11.12.2015).

Literature:
- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O'Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008
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- Johann S. Ach et. al. (Hrsg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Prerequisites / notice: The procedure for accumulating CP will be explained at the start of term.

I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.

701-0791-00L

Objective: Environmental History: An Introduction and Overview

Abstract: Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?

Objective: Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems. Improved ability to assess current problems from a historical perspective and to critically interrogate one’s own standpoint.


Prerequisites / notice: Students are asked to write an exam during the second last session (11.12.2015).

701-0985-00L

Objective: Social Intercourse with Current Environmental Risks

Abstract: The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.

701-0703-00L

Objective: Environmental Ethics

Abstract: The lecture begins with an introduction to environmental ethics. The main focus is on environmental ethics. Students learn to handle important concepts and positions in environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecologial problems and discussing them in case studies.

Objective: On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and arguments to be found within the field of environmental ethics and will have practised these in small case studies.

Content:
- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standards within environmental ethics.
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

Literature:
- Angelika Krobs (Hrsg.), Grundtexte der gegenwärtigen tier- und ökothetischen Diskussion 1997
- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
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701-0985-00L

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Objective
- Getting acquainted to the extended risk concept
- Evaluation of the risks caused by technology within the societal context
- Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology)
- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)
Knowledge about possibilities for sustainable innovation
Content
- Risks and technical systems (risk categories, risk perception, risk management)
- Illustration with case studies (nanotechnology)
- Implementation (politics, science, media, etc.)
- Decision making (technology assessment, cost/benefit analysis etc.)
- The role of the media
- prospects for future developments

Lecture notes
Copies of slides and selected documents will be distributed

Prerequisites / notice
The lecture is held biweekly (for 2 hours). The dates are 26.9., 3.10. (out of schedule), 24.10, 7.11, 21.11, 5.12, 19.12

D-MTEC

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<th>Number</th>
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<tr>
<td>851-0591-00L</td>
<td>Digital Sustainability in the Knowledge Society</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>M. M. Dapp</td>
</tr>
</tbody>
</table>

Objective
- Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS.

Abstract
How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g. Open Source/Content/Access. The course discusses consequences we do not understand and introduces «digital sustainability» as an alternative vision for society.

Objective
At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open:"free" models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff.

After the lecture, you should (hopefully) be able to:
- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

Content
Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetic», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we do not understand and introduce «digital sustainability» as an alternative vision for society.

Comparative to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music).

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

More on teach.digisus.info starting from September. Stay tuned.

Lecture notes
Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

Literature
Contents of the following books is covered (PDFs are available online):
Other recommended books are:
1 (general) Chris DiBona et al., Open Sources: Voices from the Open Source Revolution, O'Reilly, 1999.

Prerequisites / notice
For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 667 of 1571
Further information, in particular regarding computer models in the social sciences, will be provided in the course.

The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further use and unrestricted use.

<table>
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<th>Course Code</th>
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<th>Credits</th>
<th>Semester</th>
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<tr>
<td>363-0565-00L</td>
<td>Principles of Macroeconomics</td>
<td>W</td>
<td>3</td>
<td>2V</td>
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</table>

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland? This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to every-day economic problems.

**Literature**


**Prerequisites / notice**

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**363-0565-00L Principles of Macroeconomics**

**Abstract**

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland? This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to every-day economic problems.

**Objective**

This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to every-day economic problems.
This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society’s resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

The course gives an overview on the main schools in the philosophy of technology. Students should learn to analyse and evaluate different philosophies of technology (compensation, objectification, externalisation). For credit point a critical protokoll is to be written. Particularly suitable for students of D-ITET, D-MATL, D-MAVT.

Lecture notes

The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2467) contains announcements, course information and lecture slides.

Literature


We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

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<tr>
<td>851-0125-41L</td>
<td>Introduction Into Philosophy of Technology</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>O. Müller</td>
</tr>
<tr>
<td>851-0588-00L</td>
<td>Introduction to Game Theory, Models and Experimental Studies</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>A. Diekmann</td>
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</table>

Content

This course introduces the foundations of game theory. It focuses on models of social interaction, conflict and cooperation, the emergence of cooperation and concepts of strategic decision-making behaviour. Examples, applications and the contrast between theory and empirical results are particularly emphasized.

Objective

The course gives an overview on the main schools in the philosophy of technology. Students should learn to analyse and evaluate different philosophies of technology (compensation, objectification, externalisation). For credit point a critical protokoll is to be written.

Abstract

This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.

Objective

Students
- have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically interpret results of applied statistics, in particular, regarding causal inference

Content

The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.
The Role of Intellectual Property in Daily Routine: A 2S 2V


WebClass Introductory Course History of Technology

C. Soltmann

The lecture slides will be presented on the course web page after each lecture.

The lecture gives an overview of the fundamental aspects of intellectual property, which plays an important role in the daily routine of engineers. The lecture aims to make participants aware of the various methods of protection and to put them in a position to use this knowledge in the workplace.

Prerequisites

Literature


Weitere Literatur und Übungsaufgaben zum Download unter:
http://www.socio.ethz.ch/publications/spieltheorie

851-0549-00L WebClass Introductory Course History of Technology W 3 credits 2V G. Hürlimann

Number of participants limited to 100.

Abstract

WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced to basic theories and practices of the field.

Objective

Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get to know basic theories and practices of the field.

Content


Lecture notes


851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB

W 3 credits 2S D. Helbing, L. Sanders, O. Woolley

Number of participants limited to 70.

Content

This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Lecture notes

The lecture slides will be presented on the course web page after each lecture.

The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

851-0738-01L The Role of Intellectual Property in Daily Routine: A Practical Introduction

C. Soltmann

Practical Introduction

Particularly suitable for students of D-BAUG, D-ITET, D-MAVT

Abstract

The lecture gives an overview of the fundamental aspects of intellectual property, which plays an important role in the daily routine of engineers. The lecture aims to make participants aware of the various methods of protection and to put them in a position to use this knowledge in the workplace.

Weitere Informationen unter https://www.tg.ethz.ch/de/programme/
Objective

In recent years, knowledge about intellectual property has become increasingly important for engineers. Both in production and distribution and in research and development, engineers are increasingly being confronted with questions concerning the patenting of technical inventions and the use of patent information.

The lecture will acquaint students with practical aspects of intellectual property and enable them to use the acquired knowledge in their future professional life.

Topics covered during the lecture will include:
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups.

Case studies will illustrate and deepen the topics addressed during the lecture.

Prerequisites / notice

The lecture is in particular tailored to the needs of the following degree programs: Agricultural science, architecture, civil engineering, computational science and engineering, computer science, electrical engineering and information technology, environmental engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-related degree programs, the lecture 'Protecting inventions in chemistry' (851-0738-03) will be offered in the autumn semester.

851-0591-00L

Digital Sustainability in the Knowledge Society

W 2 credits 2V M. M. Dapp

Particularly suitable for students of D-INFR, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS.

Abstract

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g. Open Source/Content/Access. The course discusses consequences from different models and introduces «digital sustainability» as an alternative vision for society.

Objective

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open/free models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff.

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- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

Content

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetics», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparable to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)...

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

More on teach.disiggins.info starting from September. Stay tuned.

Lecture notes

Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

Literature

Content of the following books is covered (PDFs freely available online):

Other recommended books are:
1 (genera) Chris DiBona et al., Open Sources. Voices from the Open Source Revolution, O'Reilly, 1999.

Prerequisites / notice

For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45. Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the lecture.

851-0703-00L

Introduction to Law

W 2 credits 2V O. Streiff Gnoëff

Students who have attended or will attend the lecture "Introduction to Law for Civil Engineering and Architecture" or "Introduction to Law" (851-0708-00), cannot register for this course unit.

Particularly suitable for students of D-MAVT, D-MATL

Abstract

This class introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered.
### Objective
Students are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes.

### Content
- Basic concepts of law, sources of law.
- Private law: Contract law (particularly contract for work and services), tort law, property law.
- Public law: Human rights, administrative law, procurement law, procedural law.

### Lecture notes
- Insights into the law of the EU and into criminal law.

### Literature
- Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library).
- Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=2170).

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Period</th>
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<tbody>
<tr>
<td>851-0738-00L</td>
<td>Intellectual Property: Introduction</td>
<td>2</td>
<td>2V</td>
<td>M. Schweizer</td>
</tr>
<tr>
<td>851-0125-51L</td>
<td>Man and Machine</td>
<td>3</td>
<td>2G</td>
<td>M. Hampe</td>
</tr>
<tr>
<td>851-0306-05L</td>
<td>Literature and Technology - Simulations, Prototypes, Machines</td>
<td>3</td>
<td>2S</td>
<td>E. Edelmann-Ohler</td>
</tr>
<tr>
<td>851-0551-03L</td>
<td>Postal Knowledge and the History of Digital Societies</td>
<td>3</td>
<td>2S</td>
<td>D. F. Zetti</td>
</tr>
<tr>
<td>853-0047-01L</td>
<td>World Politics Since 1945: The History of International Relations (Without Exercises)</td>
<td>3</td>
<td>2V</td>
<td>A. Wenger</td>
</tr>
<tr>
<td>701-0703-00L</td>
<td>Environmental Ethics</td>
<td>2</td>
<td>2V</td>
<td>M. Huppenbauer</td>
</tr>
</tbody>
</table>

**Abstract**
- The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights).
- Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.

**Objective**
- The aim of this course is to enable students at ETH Zurich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.

### Literature
- Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library).
- Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=2170).

### Objective
- Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

### Content

### Objective
- Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.

### Literature
- Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library).
- Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=2170).

### Objective
- The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different models of machines will be important here: the clockwork, the steam engine and the computer.

### Literature
- Lukas Meyer.

### Objective
- On the one hand models of machines had a heuristic value in research on man, e.g. in Harvey's discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these models were always criticised, sometimes polemically, because they are supposedly not adequate for man.

### Literature
- Lukas Meyer.

### Objective
- The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different models of machines will be important here: the clockwork, the steam engine and the computer.

### Literature
- Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library).
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### Literature
- Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library).
- Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=2170).
Introduction to general and applied ethics.
Overview and discussion of ethical theories relevant to the environment.
Familiarisation with various basic standpoints within environmental ethics.
Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.).

Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.
In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, 2nd Edition Zürich 2014

- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O’Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008

General introductions:
- Marcus Düwell et. al (Hrg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et. al. (Hrg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Prerequisites / notice
The procedure for accumulating CP will be explained at the start of term.
I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.

701-0791-00L Environmental History - Introduction and Overview W 2 credits 2V D. Speich Chassé
Number of participants limited to 100.

Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?

Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems.
Improved ability to assess current problems from a historical perspective and to critically interrogate one’s own standpoint.

Prerequisites / notice
The lecture material is provided on OLAT. Students are asked to write an exam during the second last session (11.12.2015).

701-0955-00L Social Intercourse with Current Environmental Risks W 1 credit 1V B. Nowack, C. M. Som-Koller

The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.

Prerequisites / notice
The lecture is held biweekly (for 2 hours). The dates are 26.9., 3.10. (out of schedule), 24.10, 7.11, 21.11, 5.12, 19.12.

853-0725-00L History Part One: Europe (The Cradle of Modernity, Britain ca. 1789-1939) W 3 credits 2V H. Fischer-Tiné

Using the concrete example of Britain, the "cradle of modernity", this lecture offers a survey and analysis of the crucial historical transformations that engendered "modernity" in Europe from the late 18th to the mid 20th centuries.

At the end of this lecture course, students can: (a) highlight the most important changes in the "long nineteenth century" in Europe (b) explain their long-term effects; and (c) relate these changes to global developments.

Literature
- Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.

853-0750-00L Business Law W 2 credits 2V P. Peyrot

Particularly suitable for students of D-ITET, D-MAVT

The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.

The students shall obtain the following competences:
- They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise.
- They shall be acquainted with corporate functions as contracting, negotiation, claims management and dispute resolution.
- They shall be familiar with the issues of corporate compliance, i.e. the system to ascertain that all legal and ethical rules are observed.
- They shall be able to contribute to the legal management of the company and to discuss legal issues.
- They shall have an understanding of the law as a part of the corporate strategy and as a valuable ressource of the company.

Literature
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008
- Johann S. Ach et. al. (Hrg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008
- Marcus Düwell et. al (Hrg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et. al. (Hrg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Further reading
- John O'Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008
- Johann S. Ach et. al. (Hrg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008
- Marcus Düwell et. al (Hrg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et. al. (Hrg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

853-0600-00L Current Issues in Security Policy W 3 credits 2V A. Wenger, O. Tränert

This course provides an overview of the security implications of so-called “dual-use” technologies, i.e. technologies that can be used for both peaceful and military aims. The course will also cover various policies - in particular arms control - that are discussed and applied by the international community in dealing with such dual-use technologies.

Participants should gain a solid understanding of security challenges stemming from the use and control of dual-use technologies. In addition, the students should become aware of how researchers can deal with sensitive knowledge regarding research transparency and control.
The aim of the course is to provide participants with an overview of international security politics with a special focus on dual-use technologies. Students will analyze the character of dual-use security risks and of risk-based security strategies and instruments. Thematic areas include the nuclear non-proliferation regime, biological and chemical weapons conventions, missile proliferation, the nuclear programs of Iran and North Korea, cyber and space technologies, as well as robotics and nanotechnology.

Participants are expected to study the compulsory texts provided at the beginning of the semester via the online platform Moodle. An online learning platform serves as a supplement to the course.

### D-PHYS

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<th>Lecturers</th>
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<td>851-0585-15L</td>
<td>Complexity and Global Systems Science</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>D. Helbing, N. Antulov-Fantulin</td>
</tr>
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<td></td>
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<td></td>
<td>The lecture slides will be presented on the course web page after each lecture.</td>
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</table>

**Abstract**

This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.

**Objective**

Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

**Content**

This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at " tipping points", multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or "tragedies of the commons" such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course takes the student to possible ways of mitigating technosocio-economic-environmental problems, and what data science may contribute to their solution.

### Content

**Philosophy of Time**

By the end of the course students are able to describe and compare different interpretations of quantum mechanics. They are able to identify and examine issues concerning these different interpretations and issues concerning the transition between quantum and classical descriptions in physics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific contexts.

**Literature**

Further literature, in particular regarding computer models in the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

**Prerequisites**

Mathematical skills can be helpful.

### Literature


### Prerequisites / notice

Mathematical skills can be helpful.

### Notes

Particularly suitable for students of D-ITET, D-MAVT, D-MATH, D-PHYS.

### Participants

- Number of participants limited to 70.

### Type

- The course aims at providing a working knowledge of astronomy and cosmology from the ancient world to the 16th century. Upon its completion the students will be able to describe how our knowledge of the heavens changed from Aristotle's system to the Copernican Revolution. In addition, they will also have acquired an appreciation of the debates about man's place in the cosmos and the philosophical principles underpinning cosmology.

### Content

- The course provides an introduction to philosophical issues surrounding the concept of time. We will treat topics such as: the existence of past, present, and future; the possibility of time travel; the constitution of time consciousness and its possible neurophysiological counterparts; temporal biases in the conduct of our lives; responsibility to future and past generations.

### Objective

- The course aims at providing a working knowledge of astronomy and cosmology from the ancient world to the 16th century. Upon its completion the students will be able to describe how our knowledge of the heavens changed from Aristotle's system to the Copernican Revolution. In addition, they will also have acquired an appreciation of the debates about man's place in the cosmos and the philosophical principles underpinning cosmology.

### Literature

Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

### Content

- The course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

### Prerequisites

- Particularly suitable for students of D-MAVT, D-INFK, D-ITET, D-MTEC, D-PHYS.

### Notes

The lecture slides will be presented on the course web page after each lecture.

### Literature


### Participants

- A reading list will be distributed at the beginning of the semester.
### D-USYS

#### 851-0125-5BL

**Philosophy of the Environmental Sciences: An Introduction**

**Prerequisites / notice**

The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

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<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>851-0125-5BL</td>
<td>Philosophy of the Environmental Sciences: An Introduction</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>A. Schwarz</td>
</tr>
</tbody>
</table>

**Abstract**

Environmental knowledge and management is quite common in different research fields and in everyday practice. We will be identifying those concepts, objects and methods that mainly construe what might be called the core of the environmental sciences. This will be done by using different philosophical tools and approaches.

**Objective**

The environmental sciences cover a wide range of scientific practices and objects and accordingly afford different kinds of scientific knowledge. Additionally, there is an important interplay between the scientific and the societal sphere. In this seminar we will examine likewise central and widespread concepts such as sustainable development or resilience by using philosophical tools that will allow to problematize different uses of those concepts, their semantic range in terms of historical and foundational fields and finally their logical coherence. Another important topic is the philosophical investigation of methods and objects that can be identified in the environmental sciences. Those methods are for instance Life Cycle Assessment or Adaptive Ecosystem Management, technological objects may be a wind engine or a hydropower plant. The latter raise questions of how renewable energies can be assessed and valued, including the more general issue of which values and norms can be embedded in technological objects. This leads us to the third and last complex of topics that focus on current deliberations about possible new ways of existence in the age of the Anthropocene and as a consequence the formation of adequate life styles in our societies. This refers to issues in philosophical and social anthropology and the challenge of climate change.

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#### 851-0591-00L

**Digital Sustainability in the Knowledge Society**

**Prerequisites / notice**

For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

<table>
<thead>
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<td>851-0591-00L</td>
<td>Digital Sustainability in the Knowledge Society</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. M. Dapp</td>
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</table>

**Abstract**

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g. Open Source/Content/Access. The course discusses consequences from different models and introduces «digital sustainability» as an alternative vision for society.

**Objective**

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open/free models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff.

After the lecture, you should (hopefully) be able to:
- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

**Content**

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetic», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparable to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)... As a «leaver» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability». It can be downloaded from essays2020.ethz.ch.

More on teach.digisus.info starting from September. Stay tuned.

**Lecture notes**

Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

**Literature**

Content of the following books is covered (PDFs freely available online):


Other recommended books are:

1. (general) Chris DiBona et al., Open Sources: Voices from the Open Source Revolution, O'Reilly, 1999.

**Prerequisites / notice**

For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the lecture.

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#### 851-0594-00L

**International Environmental Politics**

**Prerequisites / notice**

Particularly suitable for students of D-IFR, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS.

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<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>851-0594-00L</td>
<td>International Environmental Politics</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>T. Bernauer</td>
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</table>

**Abstract**

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

**Objective**

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.
The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

### Lecture notes

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory.

Assigning reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <michaehu@student.ethz.ch>). All assigned papers must be read ahead of the respective meeting. Following the course on the basis of on-line slides and papers alone is not sufficient. Physical presence in the classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GESS library at the IFW building, Haldeneggsteig 4, B-floor, or in the library of D-USYS.

### Literature

Assigning reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <michaehu@student.ethz.ch>).

### Prerequisites / notice

None

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### 851-0705-02L Environmental Law: Topics and Case Studies

**Number of participants limited to 20.**

**Prerequisites:** Environmental Law: Conceptions and Fields (851-0705-01L) offered in spring semester.

**Abstract**

This workshop offers to the students the opportunity to intensify their environmental legal knowledge on the basis of individual topics or cases of their respective programme or professional interest in a guided self-study. They develop a better understanding for the practical application of legal regulations on environmental matters.

**Objective**

The aim of this workshop is to equip students with legal skills and methods to solve or treat problems and questions of the environmental law and foster the understanding on the possibilities and limits of legal problem-solving. The students choose an inquiry with practical relevance. To this end they work out the legal basis demonstrating a legal correct solution or approach to a solution. In doing so, students will get to know legal methods and research possibilities.

**Content**

At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a maximum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

**Lecture notes**

Den Studierenden werden Unterlagen zur juristischen Methoden- und Quellenlehre sowie zum Inhalt und Ablauf des Kurses zu Beginn der Veranstaltung kostenlos abgegeben.

**Literature**

Rechtsgrundlagen, Literatur und Gerichtsentscheide werden themenspezifisch selber reacheicht, unter Mithilfe und Beratung des Dozenten.

**Prerequisites / notice**

Die Veranstaltung erfordert die Bereitschaft, sich aktiv und selbständig mit einer selbstgewählten Fragestellung oder einem eigenen Fallbeispiel aus dem Gebiet des Umweltrechts und allenfalls aus Schnittstellengebieten auseinanderzusetzen. Damit die Interaktivität und die Begleitung der Teams gewährleistet werden kann, ist die Teilnehmerzahl auf maximal 16 Personen beschränkt. Es handelt sich um eine Vertiefungsveranstaltung. Der Besuch der Vorlesung "Umweltrecht: Konzepte und Rechtsgebiete" (851-0705-01) ist Voraussetzung.

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### 851-0707-00L Space Planning Law and Environment

**Number of participants limited to 20.**

**Practical suitability for students of D-ARCH, D-BAUG, D-USYS**

**Abstract**

System of swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, Instruments, Application, legal protection, enforcement, Practical training.

**Objective**

Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.

**Content**


**Lecture notes**

Haller, Walter/Karlen, Peter, Raumplanung-, Bau- und Umweltrecht, 3.A., Zürich 1999

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### 851-0724-00L Property Law for Geometers: Land Registry and Geoinformation Law

**Practical suitability for students of D-ARCH, D-BAUG, D-USYS**

**Abstract**

Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, of the official land surveying).

**Objective**

Overview of the legal norms of land registry and surveying law.
The aim of this course is to make students with a technical scientific background aware of the legal and political context of environmental politics at the example of specific environmental challenges of global importance. Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014

The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Students will be expected to read theoretical texts and case studies during semester, participate in discussions with external experts (historians, curators, and scientists), and to write a summarizing essay at the end of the term.

851-0735-11L Environmental Regulation: Law and Policy W 3 credits 1S
The course will be offered again in the spring semester 2017.

Number of participants limited to 15.

The aim of this course is to make students with a technical scientific background aware of the legal and political context of environmental policy in order to place technical solutions in their regulatory context.

The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.

Content
Topics covered in lectures:
(1) Environmental Regulation
a. Perspectives
b. Regulatory Challenges of Environment Problems
c. Regulatory Tools
(2) Law: International, European and national laws
a. International law
b. European law
c. National law
(3) Policy: Case studies

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Lecture notes
The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Teaching will take place over two weeks in September and October. The exam date will be in December.

During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project. An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

No specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0708-00 V) or an equivalent course.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

701-0727-00L Politics of Environmental Problem Solving in Developing Countries W 2 credits 2G
The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.
Objective
After completion of the module, students will be able to:
- Identify and appraise ecological aspects in development cooperation, development policies and developing countries’ realities
- Analyze the forces, components and processes, which influence the design, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

Content
Key issues and basic concepts related to environmental politics are introduced. Then the course predominantly builds on case studies, providing information on the context, specifying problems and potentials, describing processes, illustrating the change management, discussing experiences and outcomes, successes and failures. The analysis of the cases elucidates factors for success and pitfalls in terms of processes, key elements and intervention strategies.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and cropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008

Lecture notes
Information concerning the case studies and specific issues illustrated therein will be provided during the course (uploaded on Moodle).

Literature

Objective
The students know the opportunities and restrictions which are given by the law when using natural resources. They have insights into the complex environmental legal system and their application in concrete cases. The students are able to formulate typical legal questions, to understand the argumentation of courts and to solve simple legal problems with respect to environmental problems.

Content
The students are introduced to the fundamentals of environmental law. The main focus is on understanding the complexity of the legal situation, the interdependenz of different laws, and the application of case law. The course begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

The learning concept is based on the co-ordinated implementation of the relevant legislations. The complexity of the legal situation will be discussed by analysing virtual and real law cases focused on spatial projects and planning.

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and cropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008

Lecture notes
Den Studierenden werden Unterlagen wie eine Übersicht über den behandelten Stoff auf PP-Folien, typische Gerichtsent scheide, Zeitungsartikel etc. über neue Vorhaben mit Auswirkungen auf die Umwelt und entsprechenden Rechtsfragen abgegeben.

Literature
Griffel, A.; Raumplanungs- und Baurecht in a nutsell, Dike Verlag, Zürich/St. Gallen 2012
Rausch/Marti/Griffel; Umweltrecht Ein Lehrbuch. Herausgeber: Walter Hailer. Schultness Verlag, Zürich 2004
Rausch, H.; Panorama des Umweltrechts - Kompendium der Umweltzivilschutzvorschriften des Bundes, BUWAL-Schriftenreihe Umwelt Nr. 226, 4. A., Bern 2005
Keel/Zimmermann; Bundesgerichtliche Rechtsprechung zur Waldgesetzgebung. In URP 2009/3
Griffel A.; Raumplanungs-, und Baurecht, Entwicklung 2007, Bern 2008
Umweltrecht in der Praxis URP (Juristische Fachzeitschrift für Umweltrechtfragen, herausgegeben von der Vereinigung für Umweltrecht (VUR)
Weitere Literaturangaben erfolgen in der ersten Veranstaltung.

Prerequisites / notice

Objective
On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and arguments to be found within the field of environmental ethics and will have practised these in small case studies.

701-0743-01L Law and Natural Resources W 2 credits 2V
The course will be offered again in the spring semester 2017.

Abstract
This course teaches the possibilities and limits of the law in order to protect natural resources and landscapes against harm and nuisance. The learning concept is based on the co-ordinated implementation of the relevant legislations. The complexity of the legal situation will be discussed by analysing virtual and real law cases focused on spatial projects and planning.

701-0703-00L Environmental Ethics W 2 credits 2V M. Huppenbauer

Abstract
The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.
Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

Lecture notes
Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.

In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, 2nd Edition Zürich 2014

Literature
- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O’Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008

Generel introductions:
- Marcus Düwell et. al. (Hrsg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et al. (Hrsg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Prerequisites / notice
The procedure for accumulating CP will be explained at the start of term. I expect participants to be prepared to contribute to discussions, keeping the course interesting and lively.

Environmental Behavior in Social Context W 2 credits 2S H. Bruderer Enzler

Objective
Basic knowledge of the environmental social sciences
Overview on current fields of research and their relevance for practical application

Content

Fragen, die uns während des Semesters beschäftigen:
- Wie kommt es zu Umweltveränderungen, obwohl niemand diese beabsichtigt?
- Wer verhältnisweise umweltschonend? Wie wird dies gemessen?
- Welche Rolle spielt das Umweltbewusstsein?
- Welche Rolle spielen äussere Faktoren (Möglichkeiten, Kosten etc.)?
- Wie sehr lassen wir uns durch beeinflussen, was andere machen?
- Kooperieren wir nur, wenn auch andere dies tun?

Literature

Environmental Policy of Switzerland I W 3 credits 2V E. Lieberherr

Objective
Basic knowledge of policy analysis and the specific characteristics of Swiss environmental policy. Policy instruments, actors and processes are addressed both theoretically as well as by means of current Swiss environmental policy examples.

Content
The processes of change, overuse or destruction of the natural environment through humans have historically placed high demands on political decision-making processes. The well-grounded examination of complex political conflict situations is an important precondion for the entry into the (environmental policy) workforce or a future research career.

Literature
Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.

Environmental History - Introduction and Overview W 2 credits 2V D. Speich Chassé

Objective
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)
- Analysis and discussion of ethical dilemmas and social norms.
- Overview and discussion of ethical theories relevant to the environment.
- Improvement of ability to assess current problems from a historical perspective and to critically interrogate one’s own standpoint.

Literature
- Johann S. Ach et al. (Hrsg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008
- John O’Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008
- Marcus Düwell et. al. (Hrsg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008
- Marcus Düwell et. al. (Hrsg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et al. (Hrsg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Prerequisites / notice
The detailed semester program (syllabus) is made available to the students at the beginning of the semester.

Environmental Policy of Switzerland II W 2 credits 2S H. Bruderer Enzler

Objective
- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)
- Evaluation of the risks caused by technology within the societal context
- Familiarisation with various basic standpoints within environmental ethics.
- Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems.
- Introduction to general and applied ethics.
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

Content
Instead of lecture notes different texts on policy analysis and Swiss environmental policy are made available to the students.

Literature
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008
- John O’Neill et al., Environmental Values, 2008
- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- Marcus Düwell et. al. (Hrsg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et al. (Hrsg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Prerequisites / notice
The detailed semester program (syllabus) is made available to the students at the beginning of the semester.

Social Intercourse with Current Environmental Risks W 1 credit 1V B. Nowack, C. M. Som-Koller

Objective
- Getting acquainted to the extended risk concept
- Evaluation of the risks caused by technology within the societal context
- Familiarisation with various basic standpoints within environmental ethics.
- Introduction to general and applied ethics.
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

Content
The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.

Literature
- John O’Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008
- Marcus Düwell et. al. (Hrsg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et al. (Hrsg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Prerequisites / notice
The detailed semester program (syllabus) is made available to the students at the beginning of the semester.

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Autumn Semester 2016 Page 679 of 1571
The main objective of this course is to practice and improve the four language skills of participants (listening, speaking, reading and writing). This course targets B2/C1 French learners. It is not open to French native speakers.

Objective

Students will have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically read and assess published studies on policy evaluation

Content

The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.

Language Courses ETH/UZH

Please be advised that your online-registration at the language centre has to be simultaneous (www.sprachenzentrum.uzh.ch) as otherwise your registration for the course will not be valid.

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<td>851-0816-13L</td>
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<td>W</td>
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</tbody>
</table>

Applied Statistics and Policy Evaluation

Number of participants limited to 20.

Science, Technology, and Policy MSc and MAS in Development and Cooperation have priority.

Abstract

This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.

Objective

Students are able to use the statistical software STATA for data Analysis
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software STATA for data Analysis

Content

The main emphasis is on spoken skills, with the aim of enabling students to develop their own voice in expressing their views and developing arguments efficiently. The course also nurtures the ability to understand a general meaning in documents concerning aspects of society at large.

Applied Statistics and Policy Evaluation

This course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.
A variety of texts, including classical and modern poetry, short stories, and one short novel, are analyzed. Classwork is interactive, with Bachelor and master students at C1-C2 level. The course enhances students appreciation and understanding of literature in English.

The aims of the course are to:
* Introduce students to a variety of literary texts in English
* Help students to develop critical, creative, and personal approaches to analyzing literary texts and by extension become more astute readers in general
* Provide students with an opportunity to enhance and practice their argumentation skills in discussions and in writing
* Improve the way in which students organize their ideas and arguments in a sustained, coherent, and logical manner
* Improve students grammatical and lexical repertoire through reading and discussion
* Impart a life-long interest in literature written in English

A variety of texts, including classical and modern poetry, short stories, and one short novel, are analyzed. Classwork is interactive, with pair, small group, and plenary discussions. Writing tasks are designed to help students produce coherent and well-structured texts. Lexical work helps students to increase their range of vocabulary and allow them to apply freshly acquired vocabulary in speaking and writing.

Other requirements:
* Attend regularly throughout the semester
* Participate actively in discussions, group work, and pair work
* Do at least 3 hours' work a week outside the classroom, including reading and writing
* Complete written assignments during the semester

Important note:
The course is only open to students who register on-line via the Sprachenzentrum website during the registration period (review the SZ website) and who receive on-line confirmation that they have been accepted on this course.

851-0832-11L Advanced English for Academic Purposes (C1-C2) C1 W 2 credits 2U R. Taylor

Abstract
This course is designed for Bachelor and Master students from all disciplines, who wish to improve their English from C1 towards C2 level and train their language skills at Mastery level. Selected Academic English features are included to add value to the course to meet standard entrance requirements by leading universities and colleges worldwide.

Objective
Participants should already have reached a level of C1 (advanced), as defined in the Council of Europe Global Scale. The course is also open to participants whose level is above C1. The course aims to train and develop linguistic skills at Mastery level, with a focus on formal and informal lexis, on listening and oral communication skills, increasing fluency, accuracy and complexity of spoken language; writing well-structured descriptive texts and argumentative essays, with the aim to fulfill the language requirements for study at an English speaking university or follow University Masters Courses held in English.

Content
The course covers: a review of vocabulary building and extension, including the Academic Word List and formulaic language; input on academic reading, writing and listening comprehension; and improvement of grammatical accuracy. Special emphasis is placed on individual speaking, argumentative discourse and group discussions, to enhance fluency and confidence. Where possible, students will be asked to reflect on how the course content relates to their own academic disciplines.

Lecture notes
No script. Handouts will be delivered weekly and published on Moodle.

Literature
Materials: Texts are available online (Moodle) and as handouts.

Prerequisites / notice
All participants are expected to:
* Attend regularly throughout the semester
* Participate actively in discussions, group work, and pair work
* Do at least 3 hours' work a week outside the classroom, including reading and writing
* Complete written assignments during the semester

Important note:
The course is only open to students who register on-line via the Sprachenzentrum website during the registration period (review the SZ website) and who receive on-line confirmation that they have been accepted on this course.

851-0886-00L New Zealand Through Literature and Film (C1-C2) W 3 credits 2U M. Norgate

Abstract
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Objective
This course is designed for Bachelor and Master students from all disciplines who wish to gain an insight into New Zealand culture, history, society, and politics through New Zealand's rich tradition in literature and film while improving their English language skills further towards C2.

Content
The aim is to explore the following questions through texts and film to introduce students to New Zealand and, in a broader sense, to raise their awareness of some of the key issues affecting former colonies from early settlement to the present day: What did New Zealand mean to its early settlers? Where did the settlers come from? How did they live? What is the Treaty of Waitangi, and what is its status today? What does it mean to live in multi-cultural New Zealand today?

The course is only open to students who register on-line via the Sprachenzentrum website (in February 2015, please review the SZ webpage) and who receive on-line confirmation that they have been accepted on this course.

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The most important grammatical topic will be the imperfecto and pluscuamperfecto of subjunctive in subordinate structures.

The course aims to approach the Italian language through literature. While reading short stories the participants will deepen their linguistic and syntactic competence as well as their understanding of the Italian culture by means of written exercises and class discussions.

Important note: The course is only open to students who register on-line via the Sprachenzentrum website during the registration period (review the SZ website) and who receive on-line confirmation that they have been accepted on this course.

851-0846-01L Spanish: Grammar and Pragmatic Communication (B2.1) 
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
The course is aimed for students and staff having passed level B1.2 and for those who know and correctly use all indicative tenses, as well as the subjunctive in its present and perfect forms. On the other hand, they should be able to make themselves fluently understood in every day conversations and read intermediate level texts.

Objective
The course aims towards integrating grammar and oral/written communication. We will present new grammar topics and will introduce them into the oral practice.

Content
The most important grammatical topic will be the imperfecto and pluscuamperfecto of subjunctive in subordinate structures. Free and directed discussion will be enhanced. We will read diverse text forms from Spanish and Latin American Authors.

Lecture notes
The teacher will provide the script. A fee of CHF 4.00 for photocopies be collected.

Prerequisites / notice
The certificate and ETCS points are granted to the students who have complied with the following requirements:
- Participation in the weekly lessons (maximum 3 absences)
- A minimum of 2 hours of self study (reading and grammar exercises)
- Presentation of one of the chosen texts
- Passing of a final exam

Important information for ETH students: The enrollment in this course at the Sprachenzentrum does not enrol the student automatically for the granting of the D-GESS points. Please inform yourself.

851-0846-02L Spanish: Language and Cinema (B2-C1) 
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
The main activity of the course is the visioning of films in Spanish (Spain and Latin America), giving an emphasis on a specific thematic, vocabulary, conversation and debate.

Objective
The course aims to introduce a specific problematic in a Spanish-speaking region or country through the cinema, taking into account the geopolitical and cultural spectrum of the Spanish language. It also aims the participant to get familiarized with topics, images, customs, dialogs and vocabulary, carrying out an observation and then an analysis and comment of these elements.

Content
We work out some interaction forms focused on observation, presentation and debate. Each student does a presentation of one of the films chosen, pointing out aspects that give path to a discussion. On the other hand, he/she creates a specific glossary to be used during the lesson in which the film will be discussed.

Literature
The chosen films can be seen / borrowed from the Selbstlernzentrum (http://www.sprachenzentrum.uzh.ch/slz/index.php).

Prerequisites / notice
The certificate and ETCS points are granted to the students who have complied with the following requirements:
- Participation in the fortnightly lessons (maximum 1 absence)
- The visioning of at least 80% of the films
- Preparation (glossary and thematics) of one of the chosen films
- Entries in the blog and forum of the course

Important information for ETH students: The enrollment in this course at the Sprachenzentrum does not enrol the student automatically for the granting of the D-GESS points. Please inform yourself.

851-0826-04L Italian: Language and Literature (B2-C1) 
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
The course targets are:
- to understand complex texts namely literary short stories.
- to capture lexical and syntactic meanings in texts.
- to be able to express oneself in a clear and differentiated way in using formulations and structures taken from the texts.
- to become acquainted with the cultural and social realities characteristic of Italy as described in the short stories.

Content
Durante il corso vengono letti e commentati testi narrativi brevi particolarmente significativi sia per il lessico e le strutture linguistiche impiegate sia per i contenuti strettamente collegati a realtà culturali e sociali tipiche per l'Italia. A presentazioni, orali e scritte, s'alterneranno discussioni sui testi e riflessioni sulla costruzione dei racconti e sulle scelte lessicali e sintattiche.

Lecture notes
Materiale didattico
Il materiale didattico (testi letterari, schede lessicali e grammatiche, materiale audiovisivo ecc.) sarà messo a disposizione dall'insegnante. Verrà richiesto un contributo di CHF 5.- per le fotocopie.

Il corso è accompagnato da una classe virtuale sulla piattaforma didattica OLAT, con materiali per approfondimenti e wiki. Ulteriori informazioni verranno date all'inizio del semestre.
Prerequisites / notice

Language course for beginners. We will work with a textbook which contains easy original Greek texts. Basic knowledge of Greek grammar, vocabulary and of some characteristics of the Greek language and culture.

Participants can understand and form simple questions, messages, and requests.

Basic knowledge of Greek grammar, vocabulary and of some characteristics of the Greek language and culture.

2 credits

Abstract

In the course, different textforms will be practiced which are used in the academic domain. This includes the scientific essay, the abstract, the oral presentation, and the handout.

Objective

Mastering the structures of the academic communication in Italian.

851-0826-05L

Italian for Academic Purposes (B2)

W

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

W

2 credits

1U

A. Dal Negro

Abstract

In the course, participants learn simple basic vocabulary, common daily idiomatic expressions, and fundamental grammar. The focus is on the phonetic features of Portuguese language. Intercultural and cultural issues relating to Brazil are also taken into consideration.

Objective

Participants can talk and write about themselves and everyday topics using simple sentences. They can take part in simple daily conversations, understand and write simple messages, describe an event in a time sequence, and express wishes, assumptions, and recommendations.

851-0849-00L

Basic Course A1 (Brazilian-Portuguese)

W

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

W

2 credits

2U

P. de Avila Widauer

Abstract

This course is designed for participants with no previous knowledge of Portuguese.

This course is designed for participants with a basic knowledge of Portuguese (level A1).

The course deals with everyday topics. Participants practice simple forms of communication as these occur in daily life. Lexical and linguistic structures are taught within these contexts. Intercultural and socio-cultural issues relating to Brazil are also taken into consideration.

Objective

Participants can understand and form simple questions, messages, and requests.

851-0849-01L

Basic Course A2 (Brazilian-Portuguese)

W

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

W

2 credits

2U

P. de Avila Widauer

Abstract

Basic knowledge of Greek grammar, vocabulary and of some characteristics of the Greek language and culture.

Objective

This course is the first part of a language course which runs over four semesters, covering levels A1 and A2 of the Global European Framework. Modern Greek Language I is designed for students who have no or very little command of Modern Greek and covers level A1.1.

Practice of oral communication and study of basic vocabulary and grammar; focus on noun and adjective structures, personal and possessive pronouns, active verbs (Present Tense) and the use of adverbs. Initiation to web-based activities in Greek and enhancement of interest and activities in Greek language and culture.

Content

The course covers the areas work, home and personal interests; everyday situations and conversations in hotel, restaurant and shops; asking for the way and asking for advice; simple text materials, such as poems, songs and comics will support learning activities.

Lecture notes

- The course book by D. Dimitra & M. Papacheimona, Ellinika tora 1+1 (Greek now 1+1, including 2 audio-CD), units 1-5, Athens 2002, and workbook one, Tetradio Askiseon 1, have been ordered for the course members and are available at "Bücherladen der Stiftung Zentralstelle der Studentenschaft", Schönberggasse 2.
- Web-based activities to support and enhance classroom teaching will be accessible via Moodle, an electronic platform offered by LET of ETHZ (http://moodle.let.ethz.ch);
- Additional course materials and handouts will be distributed in class.
- A set of 1400 vocabulary cards for the entire coursebook (Ellinika tora 1+1) is available and can be ordered at the beginning of the semester.

Prerequisites / notice

All course participants are expected to attend regularly and participate actively in class
do at least 3 hours’ work at home
submit all their written work for correction
commit themselves to online-activities in the Moodle-LET online-classroom
pass all semester-tests.

All candidates who fulfill the course requirements will receive a language certificate, issued by the Language Center, awarding 2 ECTS credits.

D-GESS students will receive on-line credit points and marks, in addition to the LC-certificate.

The course is only open to students who register on-line via the Sprachzentrum-website and who receive online confirmation that they have been accepted on this course. Please note the available online-registration period!


851-0885-07L

Greek Basic Course Part I

W

Language course for beginners. We will work with a textbook which contains easy original Greek texts. Basic knowledge of Greek grammar, vocabulary and of some characteristics of the Greek language and culture.

W

3 credits

5U

R. Harder

Abstract

In this third semester "Graecum" we consolidate the knowledge of the language. The course focuses on the lecture of a Platonic dialog and of Homer's Odyssey. The course prepares the students for the final exam in January.

Objective

The students should be able to translate a Greek text on a higher level. They should have a sound knowledge of the Homeric Epos and the Platonic philosophy.

851-0885-08L

Greek Basic Course Part III

W

3 credits

4U

F. Egli Utzinger

Abstract

In the course, participants learn simple basic vocabulary, common daily idiomatic expressions, and fundamental grammar. The focus is on the phonetic features of Portuguese language. Intercultural and cultural issues relating to Brazil are also taken into consideration.

Objective

All course participants are expected to attend regularly and participate actively in class
do at least 3 hours’ work at home
submit all their written work for correction
commit themselves to online-activities in the Moodle-LET online-classroom
pass all semester-tests.

All candidates who fulfill the course requirements will receive a language certificate, issued by the Language Center, awarding 2 ECTS credits.

D-GESS students will receive on-line credit points and marks, in addition to the LC-certificate.

The course is only open to students who register on-line via the Sprachzentrum-website and who receive online confirmation that they have been accepted on this course. Please note the available online-registration period!


851-0885-09L

Modern Greek Language I (A1.1)

W

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

W

2 credits

2U

A. Rassidakis Kastrinidis

Abstract

This course is designed for participants with a basic knowledge of Portuguese (level A1).

This course is designed for participants with a basic knowledge of Portuguese (level A1).

The course deals with everyday topics. Participants practice simple forms of communication as these occur in daily life. Lexical and linguistic structures are taught within these contexts. Intercultural and socio-cultural issues relating to Brazil are also taken into consideration.

Objective

Participants can talk and write about themselves and everyday topics using simple sentences. They can take part in simple daily conversations, understand and write simple messages, describe an event in a time sequence, and express wishes, assumptions, and recommendations.

851-0885-10L

Modern Greek Language III (A2.1)

W

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

W

2 credits

2U

A. Rassidakis Kastrinidis
This is Part III of the Modern Greek language course, running over four semesters. Modern Greek III covers level A2.1 of the Global European Framework and is designed for students who have already attended courses I and II at the Sprachenzentrum UNI/ETHZ, or whose language proficiency is equivalent to level A1.2.

**Objective**

Extensive vocabulary work (approx. 400 new words); reading of elementary texts; additional practice through speaking only Greek in class; improving listening comprehension; writing short essays (about the past and the future, describing events and personal experience). Grammar work will focus on verbs (simple past, simple future, subjunctive and imperative; active and passive voice).

**Content**

Challenging everyday situations; discussion of specific topics (eg. describing pictures and photographs, talking about daily chores); elementary listening comprehension practice (dialogues, talking about events, advertisements); reading comprehension (advertisements, cooking recipes, poems).

**Lecture notes**

Keines

**Literature**

- Audio-visual materials and handouts (photocopies) will be used. Photocopies will be distributed during the semester.
- Web-based activities can be accessed via Moodle platform, supported by LET of ETHZ (http://moodle.let.ethz.ch/).

**Prerequisites / notice**

All course participants are expected to
- attend regularly and participate actively in class
- do at least 3 hours of individual study at home
- take part actively in online-activities in the Moodle-LET online-classroom
- submit their written work for correction (Semester-Portfolio)
- pass the semester-test

All participants who fulfill the course requirements will receive a language certificate, issued by the Language Center, awarding 2 ECTS credits.

D-GESS students will receive on-line credit points and marks, in addition to the LC-certificate.

The course is only open to students who register on-line via the Sprachenzentrum-website and who receive on-line confirmation that they have been accepted on this course. Please note the limited online-registration period!


All Modern-Greek-courses at the Sprachenzentrum do not exceed the beginners’ level and therefore are not suitable for greek native speakers. Non-native speakers of greek origin please contact Ms. Rassidakis before enrolling in order to check if the course is not too easy for them.

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**851-0889-00L Swedish I (A1) □**

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

**Abstract**

This course is the first of a two part Swedish-course, run over two semesters. The aim of the course is to achieve basic language skills in speaking, listening, reading and writing. The focus is based on oral skills.

**Objective**

The participants learn how to express themselves adequately in different everyday situations. Everyday conversation will be worked on and practised. The students will work on basic grammar structures and basic pronunciation.

**Literature**


A printed wordlist and additional material is distributed during the lessons. You will be asked to pay CHF 9.00 to cover the cost of the material.

**Prerequisites / notice**

Regular attendance (max 3 absences), active participation in class and a minimum of 3 hours work outside class is expected per week.

The course is only open to students who registered online via the Language Center website and who received an e-mail confirmation that they have been accepted in this course.

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**851-0889-02L Swedish II (A2.1) □**

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

**Abstract**

This course is a direct continuation of the first part of the Swedish-course. Participants should already have reached level A1. The course aims to work on grammar skills, vocabulary and oral as well as writing skills. Furthermore, Swedish pronunciation should be improved (level A2.1).

**Objective**

The participants learn to express themselves in a variety of everyday-situations. The course provides knowledge on characteristics of Swedish culture and society.

**Literature**


A printed wordlist and additional material is distributed during the lessons. You will be asked to pay CHF 9.00 to cover the cost of the material.

**Prerequisites / notice**

Regular attendance (max 3 absences), active participation in class and a minimum of 3 hours work outside class is expected per week.

The course is only open to students who registered online via the Language Center website and who received an e-mail confirmation that they have been accepted in this course.

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**851-0889-01L Polish I (A 1.1) □**

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

**Abstract**

Credits: 2

The course is planned as the first part of a two-semester crash course in Polish at level A1.1. The course covers the four core skills of listening, speaking, reading and writing. We focus on oral communicative skills as well as pronunciation and grammatical structures.

**Objective**

Target audience:

This is a course for beginners who have no prior knowledge of Polish. Therefore no diagnostic test is required.

Students learn to master a set of basic situations in developing communication skills linked with every day life. Special attention will be given to features of academic culture.

**Prerequisites / notice**

The course is only open to students who register on-line via the Sprachenzentrum-website and who receive on-line confirmation that they have been accepted on this course. Please note the limited online-registration period!


The course is only open to students who have attended Polish I (A1). The course is planned as the first part of a two-semester crash course in Polish at level A1.1. The course covers the four core skills of listening, speaking, reading and writing. We focus on oral communicative skills as well as pronunciation and grammatical structures.

Students learn to master a set of basic situations in developing communication skills linked with every day life. Special attention will be given to features of academic culture.

**Prerequisites / notice**

The course is only open to students who register on-line via the Sprachenzentrum-website and who receive on-line confirmation that they have been accepted on this course. Please note the limited online-registration period!


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### Content
Everyday situations will be covered, for instance introducing yourself and others, living and working in an academic context, personal interests), to ask for information and services (in restaurants, coffeeshops, shops) etc.

The students learn the principles of Polish pronunciation and intonation as well as basic Polish grammar needed to master the course goals.

### Literature
**Coursebook**
POLSKI krok po krok 1 (Iwona Stempka, Anna Stelmach, Sylwia Dawidek, Aneta Szynkiewicz), ISBN 978-83-930731-0-8. mp3 with audio materials, free access to interactive Polish course e.polish.eu

The coursebook will be available at
Bücherladen und Studentenladen Zentrum, Schönberggasse 2, 8001 Zürich, tel: 044 634 45 23, email: ladenz@zsuz.uzh.ch

The use of of the open-source Learning Management System OLAT will be part of the course.

### Prerequisites / notice
Students are expected to attend regularly and participate actively in class. Completion of this course requires active and continuous participation. Students should be able to dedicate at least 3 hours a week to independent study activities.

The use of of the open-source Learning Management System OLAT will be part of the course.

### Assessment:
The assessment will embrace
- a portfolio including exercises done throughout the semester
- a final test assessing the different skills trained.

### Requirements for the award of 2 ECTS credits and:
- learning achievement assessed and documented as successful
- no more than 3 absences

#### 851-0851-00L
**Russian I (A1.1) **
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

**Abstract**
This course is an introduction to Russian language (and culture) for beginners (Level A1.1). The course treats both the Cyrillic alphabet and phonetics and develops a basic vocabulary. In two terms the students acquire a basic knowledge of the most important aspects of Russian grammar.

Registration for the course at sprachenzentrum.uzh.ch is obligatory!

**Objective**
The course focuses on grammar, vocabulary, oral communication in easy everyday life situation, and cultural differences.

Working forms: Single, pair, and group work, and plenum.

**Content**
These are the contents of the course: writing and reading the Russian script; welcoming somebody; saying goodbye; presenting oneself; asking for somebody's name; addressing somebody; apologising; indicating one's place and country of origin; indicating one's profession; talking about family; saying how one is; asking for prices; ordering something in a café; talking about activities; numbers 0-400. The course is supported by the learning platform OLAT.

**Lecture notes**

#### 851-0853-00L
**Russian III (A2.1) **
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

**Abstract**
This course is a sequel to the one-year basic course. Students' level should come up to the level of the basic course (two terms, with two lessons per week). In case of doubt please contact the teacher prior to the beginning of the term.

Registration for the course at sprachenzentrum.uzh.ch is obligatory!

**Objective**
The course focuses on speaking, reading comprehension and auding as well as on cultural competence.

Working forms: Single, pair, and group work, and plenum.

**Content**
These are the contents of the course: talking about food and meals; indicating quantity; saying that one needs something or has to buy something; making sales talk; naming dishes and cutlery; making invitations; asking for an explanation of an unknown term; uttering congratulations and wishes; describing one's day; naming activities in the present, the past and the future; talking about one's way to the working place. The course is supported by the learning platform OLAT.

**Lecture notes**

#### 851-0855-00L
**Russian V (A2.2+) **
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

**Abstract**
The course Russian V requires a knowledge which should come up to the level of the four preceding courses (four terms, with two lessons per week). This corresponds to the level A2 of the "European Framework". In case of doubt please contact the teacher prior to the beginning of the term.

Registration for the course at sprachenzentrum.uzh.ch is obligatory!

**Objective**
The course focuses on speaking, reading comprehension and auding as well as on cultural competence on a A2.2+ level according to the "European Framework".

Working forms: Single, pair, and group work, and plenum.

**Content**
These are the contents of the course: talking about the weather; naming seasons and months; understanding touristic offers; uttering congratulations and wishes; describing one's day; naming activities in the present, the past and the future; making and asking for recommendations; passing on information; saying how to get to a place; making suggestions. The course is supported by the learning platform OLAT.

**Lecture notes**

#### 851-0861-00L
**Arabic I (A1.1) **
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

**Abstract**
This course forms the first part (level A1) of a five semesters' Arabic course. Its aim is to acquire a basic competence on the level of speaking, hearing skills, and also reading and writing of the Arabic script.

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<tr>
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<td>3</td>
<td>W</td>
<td>Mo - Fr 09.00-17.00 Uhr</td>
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</table>

**Objective**

The participants will be able to adequately respond to selected situations of everyday life. Conversations in everyday life and typical situations while traveling will be taught and exercised. Another important focus is the learning of the Arabic script.

**Content**

Embedded into communicative situations we will work on the following contents: to greet, to present oneself, to talk about oneself (personal identity, occupation, place of living, etc.), simple telephone calls, to ask for information, to book a room. We will pay special attention to cultural aspects.

**Literature**

Arabisch Intensiv. Grundstufe. Landesspracheninstitut in der Ruhr-Universität Bochum; Buske Verlag (www.buske.de), 2011

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**Objective**

The participants are able to behave adequately in regard to language and culture in simple, but important everyday situations. Learning and practicing vocabulary and grammar are tailored to acquire sufficient confidence to meet elementary communication needs orally and in writing.

**Content**

The communicative needs which the practical contents and situations are designed to meet relate to: saying hello, asking about somebody’s wellbeing, introducing each other, simple statements about objects and persons, asking for information and services. The participants are expected to do some of their homework on OLAT.

**Literature**

All teaching material besides the reader will be distributed in the lessons and downloaded on OLAT.

**Prerequisites / notice**

The course is open for students, post-graduate students and staff of both Zurich university and ETH without any knowledge of the Arabic language.

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**Objective**

This class aims at acquiring the elementary language competence on the level of speaking, listening and understanding as well as reading and writing of the Arabic script.

**Content**

The communicative needs which the practical contents and situations are designed to meet relate to: saying hello, asking about somebody’s wellbeing, introducing each other, simple statements about objects and persons, asking for information and services. The participants are expected to do some of their homework on OLAT.

**Literature**


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**Objective**

This course forms the third semester of a five semesters’ Arabic curriculum. We will work on the following topics: Talking about one’s life, daily routines, comparisons, wishes, orders, eventualities, preferences. Furthermore, we will pay special attention to acquiring a basic vocabulary and work on the Arabic verbal system.

**Content**

The communicative needs which the practical contents and situations are designed to meet relate to: saying hello, asking about somebody’s wellbeing, introducing each other, simple statements about objects and persons, asking for information and services. The participants are expected to do some of their homework on OLAT.

**Literature**

Arabisch Intensiv. Grundstufe. Landesspracheninstitut in der Ruhr-Universität Bochum; Buske Verlag (www.buske.de), 2011

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**Objective**

The course is designed for students with a general interest in learning the modern Chinese language or students who are planning to study in China.

**Content**

Introduction to the modern standard Chinese language (Mandarin) and script, concentrating on basic vocabulary in Pinyin and Chinese characters, elementary grammar and conversation. The main focus will be on colloquial language.

**Literature**

Im Kurs wird mit folgenden beiden Lehrmitteln gearbeitet:

1) Zhongguohua, shangce (Band 1). Lehrwerk für Chinesisch als Fremdsprache.
2) Zhongguozi, shuxie.

Beide Lehrmittel können am ersten Kurstag erworben werden.
Wir arbeiten mit folgendem Lehrmittel:

Diejenigen Studierenden, die ihre Sprachstudien weiterführen oder die Standardprüfung für Chinesisch als Fremdsprache (HSK) ablegen.

**Chinese V (A2.2+)**

3 credits

Q. Hu

This course has the following aims: the participants shall acquire an advanced competence in the field of speaking, listening, reading and writing. They will build up a number of key characters, so that 300 words should be actively mastered by the end of the semester.

Exercises in basic grammatical forms shall give a first understanding of modern Chinese syntax. All the lessons will contain a fair share of conversational practice.

**Prerequisites**

Knowledge of basic Chinese characters, elementary grammar and conversation. The main focus will be on colloquial language.

**Literature**

Wir arbeiten mit folgendem Lehrmittel:

Zhrnggquâ, fângcê und Zhngggûâ, shix (Beijing, 2007 mit Audio CD).

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**Japanese I (A1.1)**

3 credits

G. Gefter

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

**Abstract**

Elementary introduction to the Japanese language. Students acquire the basic language skills needed for everyday life communicative interactions.

**Objective**

Level A1.1 of the Common European Framework of Reference for Languages (CEFR).

**Literature**

Heinrich Reinfried, *Kompaktlehrgang Japanisch* (available at the beginning of the course, later by mail to reinfried@asiaintensiv.ch; also available in English: "Concise course in Japanese")

---

**Japanese I (A1.1)**

3 credits

I. Mosimann-Nakanishi

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

**Abstract**

Elementary introduction to the Japanese language. Students acquire a basic vocabulary together with the most frequently used sentence structures, as well as the Hiragana and Katakana syllabaries. Reading and writing training includes use of the computer for Japanese text editing.

**Objective**

Everyday conversation / Reading simple texts written with Hiragana and Katakana syllabaries / Writing simple texts about everyday topics using the Hiragana and Katakana syllabaries on the computer.
For details see www.sprachenzentrum.unizh.ch.

1. Heinrich Reinfried "Kompaktlehrgang Japanisch" or "Concise Course in Japanese" (English Version)
   This will be sold at the beginning of the course or can be ordered directly at www.asiaintensiv.ch.
   This will be sold shortly before the beginning of the semester at book shops and the Studentenladen Zentrum (Schönberggasse 2, 8001 Zürich, Tel 044 634 45 23, ladenz@zsuz.uzh.ch).

851-0883-00L Japanese III (A2.1) W 2 credits 2U I. Mosimann-Nakanishi
   Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).
   Abstract: Training in colloquial Japanese / Reading of common texts in Japanese / Application, consolidation and expansion of the basic vocabulary and sentence structures / Training in hearing
   Objective: The participants consolidate and broaden the knowledge of the modern colloquial language in Japan. One of the focuses is on the acquisition of speech methods for important everyday standard situations. At the same time the grammar knowledge will be repeated and broadened. Higher reading skills will also be strived for by learning approx. 60 new Kanji.
   Content: For details see www.sprachenzentrum.uzh.ch
   Lecture notes: We will be using this textbook: "Japanisch Intensiv Grundkurs", LSI, Buske Verlag

   Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).
   Abstract: The focus of this course is on the reading of challenging original texts from Japanese media and Japanese contemporary literature. The texts are analyzed and discussed in terms of their content and linguistic features.
   Objective: By reading selected original texts, students learn strategies for reading texts analytically. The aim is that they are able to handle Japanese sources independently, using appropriate tools.

851-0890-00L Reading Course Latin: Augustus - The First Roman Princeps W 2 credits 2U C. Utzinger
   Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).
   Abstract: The general topic of the course is Augustus. On the basis of didactically prepared texts written by various Latin authors (including Sueton, Augustus) this enigmatic figure who became the first emperor of the Roman Empire is examined.
   Objective: Students mostly prepare the texts at home for class discussion. Furthermore, important topics of basic grammar are reviewed (exercises).

851-0900-01L Norwegian (Beginners) W 3 credits 2U E. Berg
   No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 360256
   Number of participants limited to 20.
   No simultaneous online registration at the language center necessary.
   Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html
   Abstract: This language course is an introduction to Norwegian (Bokmål) as well as to the country and its culture.
   Objective: By the end of the course, you will have read some easy Norwegian texts, have written your first own texts, and be able to conduct simple conversations.
   Prerequisites / notice: European Global Scale grading: A2 (basic user)
   You are recommended to take part in the tutorial offered for this course.

851-0900-03L Norwegian III (University of Zürich) W 3 credits 2U E. Berg
   No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 360267
   Number of participants limited to 20.
   No simultaneous online registration at the language center necessary.
   Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html
   Abstract: The third part of the Norwegian-course aims at a further development of your active and passive language competence. You will finish the textbook and round it off by an individual assignment on a Norwegian theme.
   Objective: You will be reading Norwegian literature with ease and discussing various themes both in speech and in writing.

851-0900-02L Norwegian II W 3 credits 2U E. Berg
   No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 360260
   Number of participants limited to 20.
   No simultaneous online registration at the language center necessary.
   Mind the enrolment deadlines at UZH:
Abstract
This course is a continuation of the introductory course and is suited for students with elementary knowledge of Norwegian. By means of various media like articles, music and films, you will also get to know more about Norway.
European Global Scale grading: B1 (independent user)

Objective
The aim of this course is to expand your knowledge of the Norwegian grammar and vocabulary and train your oral and written skills.

<table>
<thead>
<tr>
<th>GESS Science in Perspective - Key for Type</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>W+ Eligible for credits and recommended</td>
<td>E- Recommended, not eligible for credits</td>
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<tr>
<td>O  Compulsory</td>
<td>Z  Courses outside the curriculum</td>
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<tr>
<td>W  Eligible for credits</td>
<td>Dr Suitable for doctorate</td>
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<table>
<thead>
<tr>
<th>Key for Hours</th>
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</thead>
<tbody>
<tr>
<td>V  lecture</td>
<td>P  practical/laboratory course</td>
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<tr>
<td>G  lecture with exercise</td>
<td>A  independent project</td>
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<td>U  exercise</td>
<td>D  diploma thesis</td>
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<tr>
<td>S  seminar</td>
<td>R  revision course / private study</td>
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<tr>
<td>K  colloquium</td>
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<th>ECTS</th>
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<tr>
<td>European Credit Transfer and Accumulation System</td>
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Special students and auditors need special permission from the lecturers.
Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
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<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<td>Abstract</td>
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<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<td></td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td>- Get information about recent literature on learning and instruction</td>
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<td>Prerequisites / notice</td>
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<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td>Number of participants limited to 30.</td>
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<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<td>The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<td></td>
<td>- Understanding research methods used in the empirical human sciences</td>
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<td>- Getting to know intelligence tests</td>
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<td></td>
<td>- Understanding findings relevant for education</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
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<td>Number of participants limited to 30.</td>
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<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<td>Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<td></td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<td>- Understand and critically examine information from scientific journals and media</td>
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<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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<td>Number of participants limited to 20.</td>
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<td>The successful completion of both course no. 851-0242-00L &quot;Menschliches Lernen (EW 1)&quot; and course no. 851-0238-01L &quot;Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)&quot; is a necessary prerequisite for this course.</td>
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<td></td>
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<td>In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.</td>
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<td>The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning &amp; Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)</td>
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<td></td>
<td>Learning goals include:</td>
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<td>- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.</td>
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<td>- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.</td>
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<td>- Participants can design and conduct a study that is relevant for answering their research question.</td>
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<td>- Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.</td>
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<td>see Educational Science Teaching Diploma</td>
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Subject Didactics in Geography

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4239-00L</td>
<td>Geography Didactics Geography I (University of Zurich)</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>B. Vettiger-Gallusser</td>
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<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.</td>
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Data: 06.11.2018 12:57
Autumn Semester 2016
Page 690 of 1571
Abstract  
Fundamentals (theory and practice) of specialist subject teaching for high-school geography lessons.

Objective  
The course introduces students to the practical side of geography teaching. Participants look into the understanding of this school subject over the course of time and learn:
- how to plan their teaching in the context of the valid curricula, including on an interdisciplinary basis.
- how geographical contents can be implemented in didactic and methodological terms so as to ensure that fundamental competences can be imparted to pupils (knowledge, skills, attitudes), with a view to university studies as well.
- how to foster pupils in such a way that they can think independently in terms of spatial competence and can act in a responsible manner.

Content  
Thematical Schwerpunkte
- Einführung in die Theorie der Geografiedidaktik.
- Bildungsauftrag der Geografie an Mittelschulen.
- Interesse der Lernenden am Geografieunterricht.
- Unterrichtsgestaltung und -vorbereitung: Sachanalyse, lernzielorientierte Unterrichtsplanung; Didaktische Analyse; Einführung in die Gestaltung von Lernarrangements.
- Mediendidaktik (Arbeiten mit Bildern und Karten).
- Planung einer Unterrichtseinheit (Struktur - Prozess - Verlauf).

Lernformen  
Theoretische Konzepte werden präsentiert und an Beispielen diskutiert. Die Studierenden setzen sich mit Methoden aktiv auseinander (z.B. Lernpuzzle, Fallstudie sowie Sozial-und Aktionsformen) und reflektieren dabei ihre eigenen Schülererfahrungen im Fach.

Prerequisites / notice  
Fachdidaktik I ist gleichzeitig mit dem Einführungspraktikum zu belegen. Sie gilt als Voraussetzung für Fachdidaktik II und III, sowie die FWV II und FWV III. Fachdidaktik II findet nur im Sommersemester statt.

651-4124-00L Examination Didactics

Prerequisites: Successful completion of Geography Didactics of Geography Teaching I, II, III, IV as well as FV i, II, III, Introductory Internship and Internship.

Content  
Geprüft werden:
- Fähigkeit, Geografie-Unterricht mit Bezug zur eigenen Praxis kritisch und unter verschiedenen Blickwinkeln (inhaltlich, methodisch-didaktisch) zu betrachten. Lernarrangements mit Bezug zum heutigen Bildungs- und Schulfachverständnis zu gestalten und kritisch zu hinterfragen sowie deren möglichen/erzielten Wirkungen zu diskutieren und zu begründen; Unterrichtssituationen zu reflektieren und zu evaluieren.

Literature  
Unterlagen aus der Fachdidaktischen Ausbildung
Fachdidaktischer Text nach eigener Wahl

651-4120-00L Geography Didactics IV: Mentored Project

Prerequisites: successful participation in Geography Didactics of Geography Teaching I+II+III (651-4239-00L, 651-2500-00L and 651-4118-00L).

Abstract  
Mentorierte Arbeit mit Bezug zur Fachdidaktik

Objective  
selbständige, theoretisch-erfahrungsbasierte Auseinandersetzung mit konkreter, praxisbezogener Fragestellung zum Geografieunterricht.

Content  
selbständige, mentorierte Arbeit zu einem Thema aus der Fachdidaktik mit direktem Bezug zur Lehrpraxis im Fach Geografie (z.B. zu eigenen Übungslektionen und Praktikum oder zur Unterrichtsforschung). Das Thema wird zu Beginn mit der Mentorin/ dem Mentor festgelegt.

Prerequisites / notice  
Frühstestes parallel zum Fachdidaktik- Modul III zu belegen (Pflicht für ETH-Studierende)
Abstract
The Subject Didactics III course unit comprises two blocks: one "Specialisation" block with key subjects from courses I and II and a block on "Information technology in geography teaching" with specific applications.

Objective
In Subject Didactics III, students take a more in-depth, application-oriented look at geography. Students learn about the options for using ICT to design their geography teaching and also the integral furtherance of pupils' IT competence. They plan an IT lesson, hold it and then evaluate it.
- Identify the opportunities and limits of illustrating their geography teaching with films, models and experiments.
- Look into the significance of the subjective theories for learning success and failure and discuss tuition options for a concept change (geographical case studies).

Content
Fachdidaktik III Block "Vertiefung" (1/2 Semester)
- Planung von Unterrichtseinheiten.

Fachdidaktik III Block "ICT im Geografieunterricht" (1/2 Semester)
- Fachspezifische Einsatzmöglichkeiten, Unterrichtshilfen, konkrete Anwendungen und Resultate an Beispielen kritisch reflektieren.

Lernformen
Theoretische Konzepte werden vorgestellt und an typischen Beispielen aus der Praxis illustriert. Beispiele im IT-Bereich werden von Studierenden selbst erarbeitet ("Werkstatt"), präsentiert und diskutiert.

Lecture notes
Unterlagen werden abgegeben.

Literature
Weitere Literaturangaben.

Prerequisites / notice
Fachdidaktik III kann im Frühlingssemester parallel zu Fachdidaktik II besucht werden, aber erst nach Fachdidaktik I.

### Professional Training in Geography

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-2519-01L</td>
<td>Introductory Internship (University of Zürich)</td>
<td>O</td>
<td>1 credit</td>
<td>2P</td>
<td>B. Vettiger-Gallusser</td>
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<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 090BPEP</td>
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<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<td>Simultaneous enrolment in Introductory Internship Geography (651-4219-01L), Practice Lessons for Didactics I an II (651-4219-02L) and Geography Didactics I (651-4239-03L) is compulsory.</td>
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</table>

Abstract
The Introductory Internship belongs to the parctical expertise education of the teacher training for Upper Secondary Schools and must be completed at the beginning of studies.

Prerequisites / notice
The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list).

<table>
<thead>
<tr>
<th>651-2519-02L</th>
<th>Practice Lessons for Didactics (University of Zürich)</th>
<th>O</th>
<th>2 credits</th>
<th>4P</th>
<th>B. Vettiger-Gallusser</th>
</tr>
</thead>
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<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 090BPUE</td>
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<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<td>Simultaneous enrolment in Introductory Internship Geography (651-4219-01L), Practice Lessons for Didactics I an II (651-4219-02L) and Geography Didactics I (651-4239-03L) is compulsory.</td>
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</tbody>
</table>

Abstract
The practice lessons help students to gain first experiences in teaching and to reflect the courses of the teacher training and didactics. Accurate planning (preliminary discussion, written proposal) is an integral part of this course as well as a wrap-up.

Prerequisites / notice
The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list).

<table>
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<tr>
<th>651-2517-00L</th>
<th>Teaching Internship Geography (University of Zürich)</th>
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<td></td>
<td>Prerequisites: Successful completion of Educational Science and Subject Didactics in Geography (FD I, II, III) as well as Spec. Courses in Resp. Subj. w/ Educ. Focus &amp; Further Subj. Didactics (FV I, II, III) plus completion of the introductory internship.</td>
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</table>

Abstract
The Teaching Internship takes place after successful completion of the didactics courses (I, II incl. practice lessons). The teaching internship takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching internship lasts a maximum of 10 weeks.

Prerequisites / notice
The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list).

<table>
<thead>
<tr>
<th>651-2520-01L</th>
<th>Examination Lesson I Geography ■</th>
<th>O</th>
<th>1 credit</th>
<th>2P</th>
<th>B. Vettiger-Gallusser</th>
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<tr>
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<td>Simultaneous enrolment in &quot;Examination Lesson II&quot;</td>
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</tbody>
</table>
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

On the basis of a specified topic, the candidate shows that they are in a position to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.

- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

The provision of insight into their personal, selected and also theoretically-founded didactic Aspects as well as to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.

- Die Studierenden erfahren das LektionstHEMA in der Regel 14 Tage vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten sie Informationen über den Wissensstand der zu unterrichtenden Klasse und können sie vor dem Prüfungstermin besuchen.

Die gehaltene Lektion wird kriteriernbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltene Lektion im Rahmen eines Kolloquiums (15 min).

Das Journal muss bei der Schlussbesprechung des Praktikums vorliegen. Es wird von der Praktikumslehrperson kontrolliert, visiert und akzeptiert.

- Aufgabenstellungen für die berufpraktische Ausbildung aus der Fachdidaktik Geografie.

- Merkblatt Pratikumsjournal IfE LLBM

- Die berufpraktische Ausbildung am IfE LLBM; Wegleitung und Instrumente zur Vorbereitung, Durchführung und Reflexion sowie zur Evaluation der Praktikumserfahrung.

- Der Hauptteil des Praktikumsjournals umfasst ca. sechs bis acht Seiten.

- Die Art der Darstellung des Portfolios wird durch die Studierenden bestimmt.

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- Vorgängige Überlegungen (Problemstellung bzw. Vorbereitung einzelner Lektionen) werden schriftlich dokumentiert sowie die Erfahrungen reflektiert, die bei der Umsetzung und Durchführung des Unterrichts gemacht wurden.

- Im Praktikumsjournal sollen fachwissenschaftliche Aspekte, allgemein- und fachdidaktische Überlegungen, fachlich- pädagogische und didaktische Aspekte sowie konkrete Erfahrungen aus dem Praktikum einbezogen und angemessen miteinander in Verbindung gebracht werden.

- Die Art der Darstellung des Portfolios wird durch die Studierenden bestimmt.

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- Erstellt eines Portfolios zum Praktikum mit Praktikumsjournal (6-8 Seiten) und den dazu gehörenden Dokumenten (z.B. einem Beobachtungsprotokoll; einer Unterrichtsplanung; einer Lernaufgabe; einer Prüfung).

- Vorgängige Überlegungen (Problemstellung bzw. Vorbereitung einzelner Lektionen) werden schriftlich dokumentiert sowie die Erfahrungen reflektiert, die bei der Umsetzung und Durchführung des Unterrichts gemacht wurden.

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- Die Art der Darstellung des Portfolios wird durch die Studierenden bestimmt.

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- Im Praktikumsjournal sollen fachwissenschaftliche Aspekte, allgemein- und fachdidaktische Überlegungen, fachlich- pädagogische und didaktische Aspekte sowie konkrete Erfahrungen aus dem Praktikum einbezogen und angemessen miteinander in Verbindung gebracht werden.
Current approaches to research which are of relevance to society are presented on the basis of examples and critically examined in respect of their significance for a high-school education in the subject of geography.

**Objective**

- Look at the subject knowledge in its full breadth, on the basis of current approaches to research and with the consideration of specific examples, thereby creating a specialised basis on which to critically examine specialist contents for the school subject of geography, as part of a general education, over the course of time.
- See whether and where current topics from the specialist subject (research) can be incorporated in secondary-school tuition.
- Familiarise themselves with questions and forms of cognition-oriented, moderately constructivist tuition.
- Reflect on geography teaching in an aware and theory-based manner.

**Content**

Vorlesung:

In jeweils in sich geschlossenen Vorlesungen beleuchten Dozierende die gesellschaftliche Relevanz ihrer aktuellen Forschungsansätze an konkreten Beispielen aus der Physischen Geografie und den Erdwissenschaften, der Humangeografie sowie der Methodischen Geografie. Sie thematisieren dabei die Bedeutung der Ansätze für die Gesellschaft zur Auseinandersetzung mit räumlichen Fragestellungen und Problemlösungen und diskutieren die aus ihrem Forschungsansatz und den Ergebnissen resultierenden ethischen Fragen. Sie beleuchten damit die Breite des Fachverständnisses und legen das Fundament für die kritische Auseinandersetzung mit den allgemein bildenden Fachinhalten (Kompetenzen, Fachwissen, Einstellungen), die insbesondere in der gymnasialen Ausbildung im Fach Geographie vermittelt werden sollen.

**Lecture notes**

Zu jeder Vorlesung werden Folien/Unterlagen abgegeben.

**Literature**

Wird von den jeweils verantwortlichen Dozierenden zusammengestellt.

**Prerequisites / notice**


Es wird sehr empfohlen, dieses Modul parallel zum Unterrichtspraktikum zu besuchen.

---

**Regional Geography: Lecture and Didactic Concept**

- **651-4247-00L** Arabien (University of Zürich)
  - No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
  - UZH Module Code: GEO781
  - Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

  **Abstract**
  

  **Lecture notes**
  
  Zu jeder Seminarveranstaltung werden Folien/Unterlagen abgegeben.

  **Prerequisites / notice**
  

  Es wird sehr empfohlen, dieses Modul parallel zum Unterrichtspraktikum zu besuchen.

---

**Regional Geography: Lecture and Didactic Concept**

- **651-4247-40L** Asien (University of Zürich)
  - No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

  **Abstract**
  
  Es wird empfohlen, dieses Modul parallel zum Unterrichtspraktikum zu besuchen.
Participants conduct a critical examination of regional geography in terms of the understanding of the subject and teaching in schools, and its potential for substantiated tuition is established.

Regional geography observes delimited partial areas, mapped to different scales, considering thematic and exemplary aspects. Regional geography features in this form on a large number of geography syllabuses. Against this background, the module comprises two parts. A specialist lecture on the subject takes a specific regional example to highlight current, interdisciplinary topics and case studies. The aim here is to compile specialist contextual knowledge about a region. In an accompanying seminar, this contextual knowledge is then put in the correct practical form for teaching in a school, thus ensuring that the teachers are in a position to configure regional geography teaching that has been duly reflected on from the specialist-subject, didactic and pedagogical angle.

Lecture notes
Foulmen werden zur Verfügung gestellt.

Literature
Wird je nach regionalen Fokus zusammengestellt.
Vorlesung
- Übersicht über Themen, die für eine Region typisch sind oder sich in einer Region abspielen (z. B. Arabische Halbinsel, Afrika südlich der Sahara, Asien)
- Regionale Fallstudien mit interdisziplinärem Charakter
- Differenzierte Auseinandersetzung mit kulturellen und politischen Fragen und Entwicklungen in einer Region
- Erarbeiten von bedeutenden fachwissenschaftlichen Debatten zu einer Region

Seminar
- Regional-thematische Geografie versus traditionelle Länderkunde
- Geografisches Orientierungswissen: Stellenwert
- Werteerziehung und Interdisziplinarität im regionalgeografischen Kontext
- Didaktische Analyse und Planung regionalgeografischen Unterrichts: Von der Sachanalyse über den Einstieg bis zur Bewertung
- Methoden und Recherche in der Regionalgeografie

Lernformen
Fachwissenschaftliche Aspekte werden in der Form einer Vorlesung präsentiert. Die Studierenden vertiefen nach jeder Stunde die Inhalte und setzen diese im Hinblick auf die Schulpraxis um. Dabei wird ein elektronisches Lerntagebuch geführt und über eine Lernplattform über die schulpraktische Umsetzung reflektiert. Es werden auch Materialien zusammengestellt.

Folien werden zur Verfügung gestellt.

Regional Geography: Australia and New Zealand
(University of Zurich)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: GEO799
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Excursions for Students in Minor Subject
(University of Zurich)
Book the corresponding module directly at UZH.
UZH Module Code: GEO999
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Mentored Project for Excursions for Students in Minor Subject
The mentored project has to be completed together with the excursions for Students in Minor Subject (651-2615-00).

651-2601-00L Human Geography I: One Earth - Many Worlds
(University of Zurich)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: GEO112
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

651-2613-00L Humangeography III (Geographies of Difference)
(University of Zurich)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: GEO232

Compulsory Elective Courses
Further course offerings from the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".
see Compulsory Elective Courses Teaching Diploma

Additional Requirements (ETH-Masterstudents in ERDW and AC)
Part 1

Number Title Type ECTS Hours Lecturers
651-2601-00L Human Geography I: One Earth - Many Worlds
(University of Zurich)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: GEO112
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

651-2613-00L Humangeography III (Geographies of Difference)
(University of Zurich)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: GEO232

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 696 of 1571
Prerequisite: Human Geography II (UZH Module Code: GEO122)

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Teil GEO232.1:
Das Seminar verfolgt das Ziel, ein tieferes Verständnis für sozialwissenschaftliche Grundlagen der Humangeographie zu gewinnen.
Teil GEO232.2:
In der Vorlesung und den Tutorien werden aktuelle wirtschaftsgeographische Themen behandelt. Demonstriert und erklärt wird insbesondere, wie die Wirtschaft mit Grenzen und Grenzziehungen umgeht.

Objective
- Sie vertiefen ihre theoretischen, empirischen und methodischen Fähigkeiten in folgenden Themenbereichen:
  - Gesellschaft und Raum
  - Gesellschaft und Entwicklung
  - Gesellschaft und natürliche Umwelt/Ressourcen
  - Offenheit und Geschlossenheit in Wirtschaft und Gesellschaft
  - Chancen und Herausforderungen einer globalisierten Weltwirtschaft
- Sie sind in der Lage, Verknüpfungen zwischen grundlegenden sozial- und wirtschaftswissenschaftlichen Theorien und deren Konkretisierung in der Geographie herzustellen.
- Sie können die erwähnten Themen mit ausgewähltem Faktenwissen verknüpfen und diskutieren
- Sie schulen Ihre analytischen und theoretischen Fähigkeiten und können diese in Diskussionen einbringen
- Sie können die Relevanz von weiterführenden wissenschaftlichen Texten und Vorlesungen verknüpfen und mit einem Ausgangstext verknüpfen
- Sie sind in der Lage, eine Diskussion über wissenschaftliche Themen zu strukturieren und - mit einfachen Moderationstechniken - zu moderieren

Prerequisites / notice
Besuch von GEO122.

Part 2

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<tr>
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<th>Title</th>
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<td>Physical Geography III (Geomorphology and Glaciology) (University of Zürich)</td>
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<tr>
<td>Abstract</td>
<td>Das Modul bietet eine kurze Einführung in einige Komponenten und Prozesse des hydrologischen Kreislaufs. Dabei werden einzelne Wasserspeicher (Schnee-, Boden und Grundwasser) und Flüsse zwischen den Speichern (Verdunstung, Niederschlag und Abfluss) betrachtet. Übungen ergänzen die Vorlesung.</td>
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<td>651-2603-00L</td>
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<tr>
<td>Abstract</td>
<td>The course demonstrates geography's interdisciplinary approach to contribute solving urgent challenges ahead of society. Students are encouraged to reflect on the value of interdisciplinary research at discipline level and on their individual interdisciplinary curricula. The course creates awareness of ways that concepts structure our thinking, and how they figure in research and practice.</td>
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<tr>
<td>651-2338-00L</td>
<td>Remote Sensing and Geographic Information Science III (University of Zürich)</td>
<td>W+</td>
<td>5 credits</td>
<td>2V+3U</td>
<td>University lecturers</td>
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<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO233</td>
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<td>Abstract</td>
<td>Exercices to the course Introduction Remote Sensing.</td>
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Geography Teaching Diploma - Key for Type

Q Compulsory
W+ Eligible for credits and recommended
W Eligible for credits
E- Recommended, not eligible for credits
Z Courses outside the curriculum
Dr Suitable for doctorate
### Key for Hours

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<th>Letter</th>
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<tr>
<td>V</td>
<td>lecture</td>
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<td>European Credit Transfer and Accumulation System</td>
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<td>lecture with exercise</td>
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<td>Special students and auditors need special</td>
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<td>permission from the lecturers.</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>R</td>
<td>revision course / private study</td>
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<td>Mathematical tools for the engineer</td>
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<tr>
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<td>Mathematics as a tool to solve engineering problems.</td>
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<tr>
<td>Content</td>
<td>Complex numbers.</td>
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<td></td>
<td>Calculus for functions of one variable with applications.</td>
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<tr>
<td></td>
<td>Simple Mathematical models in engineering.</td>
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<tr>
<td>Lecture notes</td>
<td>Die Vorlesung folgt weitgehend</td>
<td></td>
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<tr>
<td></td>
<td>Neben Klaus Dürrschnabel, &quot;Mathematik für Ingenieure - Eine Einführung mit Anwendungs- und Alltagsbeispielen&quot;, Springer sind auch die folgenden Bücher/Skripte empfehlenswert und decken den zu behandelnden Stoff ab:</td>
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<td></td>
<td>Urs Stammbach, &quot;Analysis III&quot; (erhältlich im ETH Store); <a href="https://people.math.ethz.ch/~stammb/analysisskript.html">https://people.math.ethz.ch/~stammb/analysisskript.html</a></td>
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</tbody>
</table>

| 401-0141-00L   | Linear Algebra and Numerical Analysis | O    | 5 credits | 3V+1U | V. C. Gradinaru, R. Käppeli |
| Abstract       | Introduction to Linear Algebra and Numerical Analysis with emphasis on both abstract concepts and algorithms. |      |         |         |                            |
| Objective      | To acquire basic knowledge of Linear Algebra and Numerical Methods. Enhanced capability for abstract and algorithmic thinking based on mathematical concepts and models. Ability to select appropriate numerical linear algebra methods, to apply them properly and to implement them efficiently in MATLAB. |      |         |         |                            |
| Literature     | K. Nipp, D. Stoffer, Lineare Algebra, VdF Hochschulverlag ETH |

| 252-0845-00L   | Computer Science I                   | O    | 5 credits | 2V+2U | M. Hirt                    |
| Abstract       | The course covers the basic concepts of computer programming. |      |         |         |                            |
| Objective      | Basic understanding of programming concepts. Students will be able to write and read simple programs and to modify existing programs. |      |         |         |                            |
| Content        | Variablen, Typen, Kontrollanweisungen, Prozeduren und Funktionen, Scoping, Rekursion, dynamische Programmierung, vektorisierte Programmierung, Effizienz. Als Lernsprachen werden Pascal und Matlab verwendet. |      |         |         |                            |

| 101-0031-01L   | Systems Engineering                 | O    | 4 credits | 3G   | B. T. Aday, C. Richmond    |
| Abstract       | An introduction to system development, analysis and optimization, and decision making, with focus on linear programming, networks, formal decision methods and economic analysis. |      |         |         |                            |
| Objective      | - to gain competency in methods used to plan and analyse systems  |      |         |         |                            |
|                | - to gain the ability to formulate, analyse and solve complex problems  |      |         |         |                            |
|                | - to gain competency in the methods used for the evaluation of multiple solutions  |      |         |         |                            |
| Content        | Introduction  |      |         |         |                            |
|                | System development  |      |         |         |                            |
|                | System analysis |      |         |         |                            |
|                | Networks |      |         |         |                            |
|                | Decision theory |      |         |         |                            |
|                | Economic analysis  |      |         |         |                            |
|                | Cost-benefit analysis  |      |         |         |                            |
| Lecture notes  | Script and transparencies as well as additional material via Moodle. The transparencies will be provided via Moodle two days before the respective class. |      |         |         |                            |

| 101-0031-02L   | Business Administration             | O    | 2 credits | 2V   | M. Passardi                |
| Abstract       | Remark: Students BSc Civil Engineering (StR2014) are not allowed to assign to 101-0033-02, but have to assign 101-0031-04 in spring semester (2. Sem). |      |         |         |                            |
| Objective      | Introduction to business administration  |      |         |         |                            |
|                | Principles of accounting and financial management  |      |         |         |                            |
|                | Financial planning and capital budgeting of projects  |      |         |         |                            |
|                | Costing systems by corporations  |      |         |         |                            |
| Lecture notes  | Script and transparencies as well as additional material via Moodle. The transparencies will be provided via Moodle two days before the respective class. |      |         |         |                            |
This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts. The course consists of lectures and exercises in groups. The lectures cover all aspects of the dynamic earth, from the history of the earth, to the formation of rocks, mountains, and oceans, and the degradation processes shaping the uppermost earth's crust.

Objective
This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts.

Content

Übungen zum Gesteinsbestimmen und Lesen von geologischen, tektonischen und geotechnischen Karten, einfache Konstruktionen.

Lecture notes
The course is based on the book Dynamic Earth from Press & Siever

Literature
Press, F.; Siever, R.: Allgemeine Geologie, Spektrum Akademischer Verlag, Heidelberg

This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in ecological research: the individual, the population, the community and the ecosystem level.

Abstract
This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts. The course consists of lectures and exercises in groups. The lectures cover all aspects of the dynamic earth, from the history of the earth, to the formation of rocks, mountains, and oceans, and the degradation processes shaping the uppermost earth's crust.

Objective
This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts.

Content

Übungen zum Gesteinsbestimmen und Lesen von geologischen, tektonischen und geotechnischen Karten, einfache Konstruktionen.

Lecture notes
The course is based on the book Dynamic Earth from Press & Siever

Literature
Press, F.; Siever, R.: Allgemeine Geologie, Spektrum Akademischer Verlag, Heidelberg

3. Semester

Compulsory Courses

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0023-01L</td>
<td>Physics</td>
<td>O</td>
<td>7 credits</td>
<td>5V+2U</td>
<td>L. Degiorgi</td>
</tr>
</tbody>
</table>

Abstract
This course will cover the basic topics in Physics and will show/display/explain with a variety of experiments the most important physical effects. The course will address classical as well as modern physics, and the interplay between basic research and applications.

Objective

Content
Elektromagnetismus: Elektrostatisch und Magnetostatisch, Strom, Spannung und Widerstand, Maxwell-Gleichungen, elektromagnetische Wellen, elektromagnetische Induktion, elektromagnetische Eigenschaften der Materie.
Thermodynamik: Temperatur und Wärme, Zustandsgleichungen, erster und zweiter Hauptsatz der Wärmekraftlehre, Entropie, Transportvorgänge.
Quantenphysik und Atomphysik.
Schwingungen und Wellen.
Grundlagen der speziellen Relativitätstheorie.

Lecture notes
Manuskript und Übungsbilder
The students are capable of analysing measurements with appropriate methods. They can optimally extract model parameters from real measurements and are able to analyse and to retrieve additional information from time series. They understand the underlying algorithms of different geodetic analysis tools and processing methods for geodetic tasks.

Objective: Mathematical modeling of engineering problems, general adjustment, minimization principles, propagation of variances, uncertainty of measurements, dealing with heterogeneous measurement types, linear/non linear regression, autocorrelation and colocation.

Lecture notes: Parameter estimation and Adjustment

Prerequisites / notice: Linear Algebra, Statistics

---

The students will be introduced to specific geodetic tasks related to construction and civil engineering. Instruments will be able to properly select, test and apply these instruments for geodetic tasks with higher accuracy requirements.

Objective: The students acquire enhanced knowledge regarding the operating mode, the application and the limitations of modern geodetic standard instruments. They will be able to properly select, test and apply these instruments for geodetic tasks with higher accuracy requirements. They will get acquainted with the typical workflow from the preparation of the field works to the digital or plotted plan. Finally, the students will be introduced to specific geodetic tasks related to construction and civil engineering.

Content: - The geomatics workflow

- Propagation of light in the atmosphere

- The modern total station

- Terrestrial Laserscanning

- Digital levels

- Field tests

- Transformations and Centering

- Trigonometric leveling

- Precision leveling

- Route planning and transition curves

- Earthworks: Area and cubature

Lecture notes: The slides and documents for enhanced study and further reading will be provided online.

### Examination Block 3

*In place of the German course 851-0703-03L Introduction to Law for Civil Engineering students can take the French course 851-0709-00L Droit civil.*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0703-03L</td>
<td>Introduction to Law for Civil Engineering ■</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>G. Hertig</td>
</tr>
<tr>
<td></td>
<td>Only for Civil Engineering BSc, Geomatic Engineering and Planning BSc, Environmental Engineering BSc and Spatial Development and Infrastructure Systems MSc</td>
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<tr>
<td></td>
<td>Students who have attended or will attend the lecture &quot;Introduction to Law for Architecture &quot; (851-0703-01L) cannot register for this course unit.</td>
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<td><strong>Abstract</strong></td>
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<td></td>
<td>This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.</td>
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<td></td>
<td>Introduction to fundamental questions of public and private law which serves as a foundation for more advanced law classes.</td>
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<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>1. Public Law</td>
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<tr>
<td></td>
<td>Constitutional law: sources of law, organization of the state, fundamental rights. Administrative law: administrative decisions, organization of the administration, administrative decisions, procedural law, basics of police, environmental and zoning law.</td>
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<tr>
<td></td>
<td>2. Private law</td>
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<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
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<tr>
<td></td>
<td>There are 'Lecture Notes' (in German) for this course.</td>
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<td><strong>Literature</strong></td>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0709-00L</td>
<td>Introduction to Civil Law</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>H. Peter</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>The course Private Law focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In addition, the course will provide a short overview of Civil Procedure and Enforcement.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td><strong>Content</strong></td>
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<td></td>
<td>Le cours de droit civil porte notamment sur le droit des obligations (droit des contrats et responsabilité civile) et sur les droits réels (propriété, gages et servitudes). De plus, il est donné un bref aperçu du droit de la procédure et de l'exécution forcée.</td>
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<td></td>
<td><strong>Literature</strong></td>
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<tr>
<td></td>
<td>Éditions officielles récentes des lois fédérales, en langue française (Code civil et Code des obligations) ou italienne (Codice civile e Codice delle obbligazioni), disponibles auprès de la plupart des librairies.</td>
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<td>Sont indispensables:</td>
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<td></td>
<td>- le Code civil et le Code des obligations;</td>
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<td>- Sont conséquents:</td>
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<td></td>
<td>- Nef, Urs Ch.: Le droit des obligations à l'usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne</td>
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<td></td>
<td>- Bolliod, J.-P.: Manuel de droit, éd Slatkine, Genève</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Remarques</td>
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<tr>
<td></td>
<td>- Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours &quot;Recht I&quot; et &quot;Recht II&quot; en langue allemande et des exercices y relatifs.</td>
<td></td>
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<tr>
<td></td>
<td>- Les examens peuvent se faire en français ou en italien.</td>
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<tr>
<td></td>
<td>- Examen au 1er propédeutique; convient pour travail de semestre.</td>
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</table>

## 5. Semester

### Compulsory Courses 5. Semester

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0126-00L</td>
<td>Geodetic Reference Systems</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Meindl</td>
</tr>
<tr>
<td></td>
<td>Fundamentals and theory of geodetic reference systems and frames. Introduction to current international systems as well as to systems for the Swiss national geodetic survey.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Provision of fundamental knowledge and theory to get familiar with the applications of geodetic reference systems. Special emphasis will be placed on international global systems as well as on the systems of the Swiss national geodetic survey.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Various coordinate systems and transformations;</td>
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<tr>
<td></td>
<td>reference systems and frames (inertial, Earth-fixed, topocentric) and associated transformations between the systems; introduction to Earth rotation theory; time systems;</td>
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<td></td>
<td>Swiss national geodetic survey</td>
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<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
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<tr>
<td></td>
<td>Script will be provided electronically as pdf file.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>If possible, a field trip to the geodetic fundamental station Zimmerwald (Bern) will be offered.</td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>103-0184-00L</td>
<td>Higher Geodesy</td>
<td>O</td>
<td>5</td>
<td>4G</td>
<td>M. Rothacher</td>
</tr>
</tbody>
</table>

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Data: 06.11.2018 12:57   Autumn Semester 2018   Page 702 of 1571
Objective
Overview over the entire spectrum of Higher Geodesy

Content

Lecture notes

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>103-0435-01L</td>
<td>Land Management</td>
<td>O</td>
<td>5</td>
<td>4G</td>
<td>G. Nussbaumer, F. Frei, M. Huhmann, R. Michelon</td>
</tr>
</tbody>
</table>

**Elective Block: GIS, Photogrammetry and Cartography**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0515-00L</td>
<td>Project Management</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>M. Kersting</td>
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</table>

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0415-01L</td>
<td>Railway Infrastructures (Transportation II)</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>U. A. Weidmann</td>
</tr>
</tbody>
</table>

**Elective Block: GIS, Photogrammetry and Cartography**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0245-01L</td>
<td>Thematic Cartography</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>L. Hurni</td>
</tr>
</tbody>
</table>

Abstract

Abstract
First part: Spatial planning on the Commune level with focus on the special land use management. Second part: land re-allocation as an instrument of spatial planning; specific explanations for land re-allocations in rural regions and in construction zones.

Objective
Getting knowledge in spatial planning and land re-allocation as an interactive process.

Content
PART 1: Spatial Planning and Special Land Use Management
- Overview about Spatial Planning on the commune level
- workflows and planning methods on the commune level
- comprehension of the public
- getting knowledge of the special land use management

PART 2: Methods of Land Re-Allocation
- Intensions and principles of land re-allocation
- implementation of the land re-allocation
- land re-allocation in construction zones
- amelioration

PART 3: Agricultural Planning
Lecture notes
Lecture notes and slides (in German) can be downloaded from the PLUS homepage.

Literature
Download: [http://www.irf.ethz.ch/plus/education](http://www.irf.ethz.ch/plus/education)
### Elective Block: Geodesy and Geodetic Metrology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0125-00L</td>
<td>Geodetic Networks and Parameter Estimation</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>S. Guillaume</td>
</tr>
</tbody>
</table>

**Abstract**

This course provides knowledge for parameter estimation and data analysis in geodetic networks. The necessary mathematical and statistical methods are explained and applied by means of concrete examples.

**Objective**

The students are able to plan, pre-analyse and perform analysis of geodetic networks for practical problems. They are able to understand and develop geodetic software.

**Content**

- Refreshment of statistical and probabilistic basics (simulations with random number generators, correlated random noise, empirical density functions, hypothesis tests), 2D + 1 and 3D terrestrial and satellite based observation equations, coordinate transformation (Helmert, affine), geodetic datum problem (free networks, stochastic datum, constrained datum), quality indicators of geodetic networks (global and local accuracy resp. reliability), robust estimators (M-estimators, L-estimators, LMS-estimator), network optimization (manual, semi-automatic), measurement and distribution functions (agreement test, S-transformations).

**Prerequisites / notice**

Linear algebra, statistic and probability, geoprocessing and parameter estimation, geodetic metrology

### Elective Block: Spatial Development and Environmental Planning

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>103-0315-03L</td>
<td>Planning III</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Grét-Regamey, U. Wissen Hayek</td>
</tr>
</tbody>
</table>

**Abstract**

Independent development of a basis for decision-making and preparation of specific project documents in the context of practical spatial and environmental problems.

**Objective**

The students know different GIS-based techniques and methods for analysis of landscape and urban areas as well as GIS-based process models and can implement these for quantifying urban qualities in planning processes.

**Content**

Current topics from planning practice lead to a practical task in the context of sustainable urban development. A systematic approach of choosing suitable planning and analysis methods is shown and implemented on a concrete project. The results of the GIS-based analysis serve for developing possible solutions. Different alternatives are evaluated with selected indicators and discussed.

**Lecture notes**

No script. Handouts will be provided.

**Prerequisites / notice**

GIS-skills would be advantageous.

### Elective Block: Transport

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<tr>
<th>Number</th>
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</table>

**Abstract**

Notice

Further information at [http://www.karto.ethz.ch/studium/lehrangebote.html](http://www.karto.ethz.ch/studium/lehrangebote.html)
401-0647-00L
Introduction to Mathematical Optimization
W 5 credits 2V+1U D. Adjiashvili

Abstract
Introduction to basic techniques and problems in mathematical optimization, and their applications to problems in engineering.

Objective
The goal of the course is to obtain a good understanding of some of the most fundamental mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems. The students will also practice applying the learned models to problems in engineering.

Content
Topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).
- Modelling with mathematical optimization: applications of mathematical programming in engineering.

Literature
Information about relevant literature will be given in the lecture.

Prerequisites / notice
This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

363-0503-00L
Principles of Microeconomics
W 3 credits 2G M. Filippini

Abstract
The course introduces basic principles, problems and approaches of microeconomics.

Objective
The learning objectives of the course are:

1. Students must be able to discuss basic principles, problems and approaches in microeconomics. (2) Students can analyse and explain simple economic principles in a market using supply and demand graphs. (3) Students can contrast different market structures and describe firm and consumer behaviour. (4) Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole. (5) Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.

Lecture notes
Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature
The book can also be used for the course "Principles of Macroeconomics" (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:

Complementary:

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-BAUG.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Electives
The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Recommended Electives of Bachelor Degree Programme

Number Title Type ECTS Hours Lecturers
252-1425-00L Geometry: Combinatorics and Algorithms W+ 6 credits 2V+2U+1A B. Gärtner, E. Welzl, M. Hoffmann, A. Pilz

Abstract
Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)

Objective
The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains.

In particular, we want to prepare students for conducting independent research, for instance, within the scope of a thesis project.

Content
Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in R^d, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.

Literature

Prerequisites / notice
Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH.

Outlook: In the following spring semester there is a seminar "Geometry: Combinatorics and Algorithms" that builds on this course. There are ample places for Semester-, Bachelor- and Master Thesis projects in the area.

103-0240-00L
Cartography Seminar
W 4 credits 9S L. Humi

Abstract
Independent scholarly piece based on up-to-date papers, text books, and internet sources.

Objective
Analysis and evaluation of text and other sources; structuring and writing a concise and reader-friendly seminar report.

Content
German

Lecture notes
An information sheet will be distributed in the beginning by the supervisor.

Literature
Text references and internet sources will be distributed in the beginning by the supervisor.

Prerequisites / notice
Cartography 1

103-0241-00L
Cartography Lab 1
W 6 credits 13S L. Humi

Data: 06.11.2018 12:57
Autumn Semester 2016
Page 705 of 1571
Abstract
Independent practical work in cartography

Objective
Independent practical work in cartography

Content
Choice of theme upon individual agreement

Prerequisites / notice
German or English

103-0242-00L Cartography Lab 2
Abstract
Independent practical work in cartography
Objective
Independent practical work in cartography
Content
Choice of theme upon individual agreement
Prerequisites / notice
German or English

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The students learn to develop, assess and realize concepts and solutions for real-world problems in Engineering Geodesy. They advance

4 credits

Image Interpretation
R. Mautz

Actual real-world problems are chosen for this lab depending on the number, background and experience of the students.

Image (and point-cloud) interpretation tasks: semantic classification (e.g. land-cover mapping), physical parameter estimation (e.g. forest biomass), object extraction (e.g. roads, buildings), visual assistant; Image coding and features; probabilistic inference, generative and discriminative models; clustering and segmentation; continuous parameter estimation, regression; classification and labeling; atmospheric influences in satellite remote sensing;

C. Bishop: Pattern Recognition and Machine Learning

basics of probability theory and statistics; basics of image processing; elementary programming skills (Matlab);

103-0137-00L

Engineering Geodesy
A. Wieser, E. Serantoni

Introduction to Engineering Geodesy: methods, instruments, and applications.

The students will be introduced to the methods, instruments and applications in Engineering Geodesy with a focus on end-to-end quality assessment, sensor and multi-sensor-systems, setting out, and monitoring of engineering objects. They will be able to acquire enhanced knowledge and fundamental competences in high-precision angle, distance and height measurements. They will be introduced to aspects of interdisciplinary work in particular related to construction processes and civil engineering.


Photogrammetry and 3D Vision Lab
Wieser J. D. Wegner

Photogrammetry and 3D Vision Lab
W. 3 credits 2P
J. D. Wegner

Prerequisites: It is suggested that students take the course "Photogrammetrie" at bachelor level before this one.

Prerequisites: A recommended prerequisite for taking this course are the Bachelor courses "Photogrammetrie", "Bildverarbeitung" and "Photogrammetrie II". If you have not passed them, please contact the main lecturer of the course before enrolling. The course will include both practical work with commercial software, and programming in Matlab.

Photogrammetry and 3D Vision Lab
Prerequisites / notice

Photogrammetry and 3D Vision Lab
Abstract

The course deals with selected topics of close-range photogrammetry and geometric computer vision, including wide-baseline image matching and reconstruction, dense surface reconstruction, image search and indexing; emphasis is put on reading and self-study and on practical project work, typically in groups.

Objective

The aim of the course is to get to know the methods and practice of close-range photogrammetric reconstruction, and an in-depth understanding of selected topics in modern close-range photogrammetry and computer vision.

Content

This course builds in part on the courses "Photogrammetrie", "Bildverarbeitung" and "Photogrammetrie II" from the Bachelor program. It focuses on the particular challenges of automated close-range photogrammetry.

Lecture notes

Presentation slides, necessary publications and complementary learning materials will be provided through a dedicated course web-site.

Literature

Recommended textbooks:
- T. Luhmann. Nahbereichsphotogrammetrie (also available in English )
- R. Hartley and A. Zisserman. Multi-view geometry in computer vision
- R. Szeliski. Computer Vision

Prerequisites / notice

A recommended prerequisite for this course are the Bachelor courses "Photogrammetrie", "Bildverarbeitung" and "Photogrammetrie II". If you have not passed them, please contact the main lecturer of the course before enrolling. The course will include both practical work with commercial software, and programming in Matlab.

Engineering Geodesy Lab
A. Wieser, R. Mauth

Development of concepts and solutions for challenging tasks in Engineering Geodesy using real-world examples

The students learn to develop, assess and realize concepts and solutions for real-world problems in Engineering Geodesy. They advance the knowledge and skills which they have acquired in relation with geodetic metrology, engineering geodesy. They establish links between these subjects. Particular attention is paid to the selection of appropriate sensors and measurement systems, selection of appropriate measurement and data processing methods, end-to-end quality control, fulfilment of non-technical criteria, and to the documentation of the work.

Objective

Actual real-world problems are chosen for this lab depending on the number, background and experience of the students.

Content

In Fall 2016 one of the problems will be a study of the layout of railway tracks associated with changes of a train station, carried out under various technical and legal restrictions.

An additional problem will be chosen in connection with current research projects within the Geosensors and Engineering Geodesy Group. Examples of such problems are:
- high-precision transfer of coordinates and orientation through a long vertical shaft
- monitoring of the deformation of an ice-palace
- development of a 2D-machine-control-and guidance system
- bridge vibration monitoring
The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

### 103-0787-00L Project Parameter Estimation

**Abstract**
Solving engineering problems with modern methods of parameter estimation for network adjustment in a real-world scenario; choosing adequate mathematical models, suitable data-flow and performing software analysis.

**Objective**
Learn to solve engineering problems with modern methods of parameter estimation in a real-world scenario.

**Content**
Analysis of the given problem, selection of effective mathematical models, use of appropriate software.

**Lecture notes**
Assignment of tasks; selected documentation

**Literature**
Prerequisite: Statistics and Probability Theory, Geoprocessing and Parameter estimation, Geodetic Reference Systems and Networks

### 102-0617-00L Basics and Principles of Radar Remote Sensing for Environmental Applications

**Abstract**
The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

**Objective**
The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. At the end of the course the student has the understanding of 1. SAR basics and principles, 2. SAR polarimetry, 3. SAR interferometry and 4. environmental parameter estimation from multi-parametric SAR data.

**Content**
The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following: 1. Introduction into SAR basics and principles, 2. Introduction into electromagnetic wave theory, 3. Introduction into scattering theory and decomposition techniques, 4. Introduction into SAR interferometry, 5. Introduction into polarimetric SAR interferometry, 6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.).

**Lecture notes**
Handouts for each topic will be provided

**Literature**
First readings for the course:
Complete literature listing will be provided during the course.

### 851-0724-00L Property Law for Geometers: Land Registry and Geoinformation Law

**Abstract**
Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

**Objective**
Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).

**Content**
Overview of the legal norms of land registry and surveying law.

**Lecture notes**
Abgegebene Unterlagen: Skript in digitaler Form

**Literature**
Pflichtlektüre: Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014
- Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Zürich 2014
- Meinrad Huser, Geo-Informationsrecht, Rechtlicher Rahmen für Geographische Informationssysteme, Zürich 2005
- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBGR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

**Prerequisites / notice**
Requirements: Property Law (12-722)

### 103-0687-00L Cadastral Systems

**Abstract**
Nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs).

**Objective**
The students will get an understanding of the nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). The Swiss cadastral system as well as a range of international approaches both in developed and developing countries will be reviewed.

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Data: 06.11.2018 12:57  Autumn Semester 2016  Page 708 of 1571
Students are able to analyse data in view of specific scientific questions and interpretations. They have basic methodologies at hand to:

- Timeseries analysis
- Fourier transformation, DFT
- Auto-, crosscorrelation
- ARMA
- Interpretation of measurements
- Parameter estimation

Astro and Gravity Lab

K. Sander

Knowledge of up-to-date astro-geodetic methods aiming at the determination of the direction of the local plumb line in terms of:

- Astronomical latitude and longitude.
- Atmospheric parameters.
- Equation of motion of the unperturbed and perturbed satellite orbit.
- Perturbation theory and orbit determination.

Basics of wave propagation in the rotation and gravity field of the Earth and the atmosphere), in national surveying and navigation.

Overview of GPS, VLBI, Satellite and Lunar Laser Ranging (SLR/LLR), Satellite Radar Altimetry with the basic principles, the instruments and observation equations. Modelling of the station motions and the estimation of station coordinates. Basics of wave propagation in the atmosphere. Signal propagation in the ionosphere and troposphere for the different observation techniques and the determination of atmospheric parameters.

Equation of motion of the unperturbed and perturbed satellite orbit. Osculating and mean orbital elements. General and special perturbation theory and the determination of satellite orbits.

Additional literature will be distributed during lectures.

263-5902-00L Computer Vision W 6 credits 3V+1U+1A L. Van Gool, V. Ferrari, A. Geiger

Abstract

The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored in the exercises.

Objective

The objectives of this course are:

1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve those.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

Content

Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

Prerequisites / notice

It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

051-0203-15L 360° - Reality to Virtuality W 4 credits 4G K. Sander, A. Wieser

Abstract

Basics of 3D-scanning of rooms and bodies, individual scan projects, 3D-visualizations and animations. Working alone and in groups.

Objective

Understanding of 3D-technologies, handling positive and negative spaces, handling hardware and software, processing 3D-data (registering of scans, precision, interconnecting, filtering, visualizations and animations), interpretation of the generated data.

Content

1. Introduction in hardware and software (getting to know technologies and context, administer tests)
2. Project development within the group (idea, concept, target, intention, election of methods, strategies)
3. Project implementation within the group (possible results, videos, pictures, prints, publications, web, blog, forum etc.)
4. Project presentation (exhibition incl. critiques, discussions)

Major in Space Geodesy and Navigation

Number Title Type ECTS Hours Lecturers

103-0187-01L Space Geodesy O 4 credits 3G M. Rothacher

Abstract


Objective

Understanding the major observation techniques in space geodesy as modern methods applied in Earth system monitoring (geometry, rotation and gravity field of the Earth and the atmosphere), in national surveying and navigation.

Content

Overview of GPS, VLBI, Satellite and Lunar Laser Ranging (SLR/LLR), Satellite Radar Altimetry with the basic principles, the instruments and observation equations. Modelling of the station motions and the estimation of station coordinates. Basics of wave propagation in the atmosphere. Signal propagation in the ionosphere and troposphere for the different observation techniques and the determination of atmospheric parameters.

Equation of motion of the unperturbed and perturbed satellite orbit. Osculating and mean orbital elements. General and special perturbation theory and the determination of satellite orbits.

Lecture notes

Script M. Rothacher "Space Geodesy"

103-0657-01L Signal Processing, Modeling, Inversion O 3 credits 2G A. Geiger

Abstract

Timeseries analysis, orthogonal decomposition, interpretation of measurements, Parameterestimation and Inversion of analytical and voxel-type models

Objective

Students are able to analyse data in view of specific scientific questions and interpretations. They have basic methodologies at hand to mathematically formulate engineering and scientific problems. Students know terminologies and basic methodologies in order to be able to further study the expert literature.

Content

Timeseries analysis, fourier transformation, DFT, auto-, crosscorrelation, ARMA Interpretation of measurements, Parameterestimation and Inversion of analytical and voxel-type models, resolution, uncertainties

Lecture notes

Lecture notes

Geoprocessing

Alain Geiger

Prerequisites / notice

Courses corresponding to:

Analysis I+II, Geoprocessing and Parameterestimation, Linear Algebra I

103-0627-00L Astro and Gravity Lab W 5 credits 4P S. Guillaumé

Abstract

Knowledge of up-to-date astro-geodetic methods aiming at the determination of the direction of the local plumb line in terms of astronomical latitude and longitude.

Objective

Knowledge of the astro-geodetic methods aiming at the determination of the direction of the local plumb line in terms of astronomical latitude and longitude.

Content

Earth- and space fixed coordinate systems and their changes in time, basic astronomic calculation procedures, time scales, time keeping, transformations, star catalogues, computation of precise apparent places, relevant methods for the determination of latitude/longitude, CCD technique and astrometry, application of deflections of the vertical as regards the geoid determination.

Lecture notes

div. sources

additional literature will be distributed during lectures
Project Parameter Estimation

**Abstract**
Solving engineering problems with modern methods of parameter estimation for network adjustment in a real-world scenario; choosing adequate mathematical models, suitable data-flow and performing software.

**Objective**
Learn to solve engineering problems with modern methods of parameter estimation in a real-world scenario.

**Content**
Analysis of the given problem, selection of effective mathematical models, use of appropriate software.

**Lecture notes**
Assignment of tasks; selected documentation

**Prerequisites / notice**
Prerequisite: Statistics and Probability Theory, Geoprocessing and Parameterestimation, Geodetic Reference Systems and Networks

**Basics and Principles of Radar Remote Sensing for Environmental Applications**

**Abstract**
The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

**Objective**
The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. At the end of the course the student has the understanding of:
1. SAR basics and principles,
2. SAR polarimetry,
3. SAR interferometry and
4. environmental parameter estimation from multi-parametric SAR data

**Content**
The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:
1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarmetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

**Lecture notes**
Handouts for each topic will be provided

**Literature**
First readings for the course:
Complete literature listing will be provided during the course.

**Cadastral Systems**

**Abstract**
Nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs).

**Objective**
The students will get an understanding of the nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). The Swiss cadastral system as well as a range of international approaches both in developed and developing countries will be reviewed.

**Content**
Origins and purposes of cadastral systems
Importance of documentation
Basic concepts of cadastral systems (real estate, legal basis, conceptual principles, property-ownership, property types)
Swiss cadastral system:
- legal basis
- organization
- technical elements
- methods of data acquisition and maintenance
- profession
- quality assurance
Digital revolution, access to data
Benchmarking and evaluation of cadastral systems
International trends, developments and initiatives

**Lecture notes**
see: http://www.geo21.ch/ethz/

**Literature**
see also: http://www.geo21.ch/ethz/

**Property Law for Geometers: Land Registry and Geoinformation Law**

**Abstract**
Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).

**Objective**
Overview of the legal norms of land registry and surveying law.

**Content**
Basic principles of material and formal land registry law, components of the land register, consequences of the land register, the registration process, legal problems of surveying, the reform of official surveying, liability of the geom-eter. The lecture unit is carried out within a frame of 8 sessions (2 hours); the first hour of each is given in the form of a lecture, the second in the form of a case-study.

**Lecture notes**
Abgegebene Unterlagen: Skript in digitaler Form

**Literature**
- Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014
- Meinrad Huser, Geo-Informationsrecht, Rechtlicher Rahmen für Geographische Informationssysteme, Zürich 2005
- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBGR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

**Property Law for Geometers: Land Registry and Geoinformation Law**

**Abstract**
Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

**Objective**
Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).

**Content**
Overview of the legal norms of land registry and surveying law.

**Lecture notes**
Abgegebene Unterlagen: Skript in digitaler Form

**Literature**
- Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014
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- Meinrad Huser, Datenschutz bei Geodaten
Cadastral Systems

Basic methods, technologies, scripting, and systems for interactive web mapping projects and in the internet cartography.

Choice of theme upon individual agreement

Nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). The Swiss cadastral system as well as a range of international approaches both in developed and developing countries will be reviewed.

1. Plate Tectonics before Space Geodesy.

Students will get a detailed overview of advanced GIS topics. They will go through all steps of setting up a Web-GIS application in the labs.

---

### Major in GIS and Cartography

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>103-0227-00L</td>
<td>Cartography III</td>
<td>O</td>
<td>5</td>
<td>4G</td>
<td>L. Hurni</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic methods, technologies, scripting, and systems for interactive web mapping projects and in the internet cartography.</td>
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<tr>
<td>Objective</td>
<td>Gain knowledge about basic methods, technologies, scripting, and systems for interactive web mapping projects. Assessment of existing products regarding production methods. Definition of useful methods for Web-based map projects.</td>
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<tr>
<td>Content</td>
<td>Web mapping, Web Map Services (WMS), User Interface design, Symbolisation, Programming, - Debugging, Map production using GIS data, 3D applications in cartography</td>
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<td>Lecture notes</td>
<td>Own script and instructions will be distributed.</td>
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<td></td>
<td>Further information at <a href="http://www.karto.ethz.ch/studium/lehrangebot.html">http://www.karto.ethz.ch/studium/lehrangebot.html</a></td>
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<tr>
<td>103-0237-00L</td>
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<td>O</td>
<td>5</td>
<td>3G</td>
<td>M. Raubal</td>
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<tr>
<td>Abstract</td>
<td>The course deals with advanced topics in GIS; GIS project lifecycle, Managing GIS, Legal issues, GIS assets &amp; constraints; Geospatial Web Services; technical basics, architecture, functions, interoperability, standards, mashups, portals, applications; Geostatistics; Sensor Web Enablement; Human-Computer Interaction; Cognitive Issues in GIS.</td>
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<tr>
<td>Objective</td>
<td>Students will get a detailed overview of advanced GIS topics. They will go through all steps of setting up a Web-GIS application in the labs and perform other practical tasks relating to Sensor Web Enablement, Human-Computer Interaction, Geostatistics, and Web Processing Services.</td>
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<td>Content</td>
<td>Independent practical work in cartography</td>
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<td>Content</td>
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<td>D. M. Steudler</td>
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<tr>
<td>Abstract</td>
<td>Nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs).</td>
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<td>Objective</td>
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Content
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- Importance of documentation
- Basic concepts of cadastral systems (real estate, legal basis, conceptual principles, property-ownership, property types)
- Swiss cadastral system:
  - legal basis
  - organization
  - technical elements
  - methods of data acquisition and maintenance
  - profession
  - quality assurance
- Digital revolution, access to data
- Benchmarking and evaluation of cadastral systems
- International trends, developments and initiatives

Lecture notes
see: http://www.geo21.ch/ethz/

Literature
- see also: http://www.geo21.ch/ethz/

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<tr>
<td>851-0724-00L</td>
<td>Property Law for Geometers: Land Registry and Geoinformation Law</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Huser</td>
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<tr>
<td></td>
<td>Particularly suitable for students of D-ARCH, D-BAUG, D-USYS</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official (land surveying).)</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Overview of the legal norms of land registry and surveying law.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Basic principles of material and formal land registry law, components of the land register, consequences of the land register, the registration process, legal problems of surveying, the reform of official surveying, liability of the geom-eter. The lecture unit is carried out within a frame of 8 sessions (2 hours): the first hour of each is given in the form of a lecture, the second in the form of a case-study.</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td>Abgegebene Unterlagen: Skript in digitaler Form</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Requirements: Property Law (12-722)</td>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>103-0258-00L</td>
<td>Interoperability of GIS</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Krummenacher</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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</table>
|         | Content: Transform back and forth (geo-)data with same content but different structure.
|         | Tools: Conceptual schema languages UML and INTERLIS, formats ITF, XML, tools ILI-Checker and awk, and for the semantic transformation UMLT and FME. |      |      |       |                    |
|         | **Objective**                                                         |      |      |       |                    |
|         | - Explain and apply the model-driven approach based on standards      |      |      |       |                    |
|         | - Know and use interoperability types                                 |      |      |       |                    |
|         | - Know transfer formats and reformat with 1:1 processors              |      |      |       |                    |
|         | - Explain object-oriented modelling (with graphic and text)           |      |      |       |                    |
|         | - Know and use communication technologies and OGC Web services        |      |      |       |                    |
|         | - UML, EBNF, INTERLIS, ITF, XML, awk, FME                            |      |      |       |                    |
|         | - Know and apply appropriate software tools                           |      |      |       |                    |
|         | **Content**                                                           |      |      |       |                    |
|         | Semantic interoperability of GIS is in the main part of this lecture and means to transform back and forth (geo-) data with same content but different structure. The reduction of the necessary programming amount to a modest minimum is provided by the system-independent model-driven approach. Its elements reality selection, conceptual modelling, flexible standard formats, 1:1 processors and semantic transformation are presented and used. As generally useful tools are introduced and applied the conceptual schema languages UML and INTERLIS, the flexible transfer formats ITF, the XML the ILI-Checker, the efficient reformating tool awk and for the semantic transformation UMLT and FME. |      |      |       |                    |
|         | **Prerequisites / notice**                                            |      |      |       | Condition for participation: Successful bachelor lecture GIS II |

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<tr>
<td>103-0778-00L</td>
<td>GIS and Geoinformatics Lab</td>
<td>W</td>
<td>4</td>
<td>4P</td>
<td>M. Raubal</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Independent study project with (mobile) geoinformation technologies.</td>
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<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Learn how to work with (mobile) geoinformation technologies (including application design and programming).</td>
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**Major in Planning**

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<th>Lecturers</th>
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<tbody>
<tr>
<td>103-0347-00L</td>
<td>Landscape Planning and Environmental Systems</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>A. Grét-Regamey</td>
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<td>Only for master students, otherwise a special permission</td>
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<td>by the lecturers is required.</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>In the course, methods for the identification and measurement of landscape characteristics, as well as measures and implementation of landscape planning are taught. Landscape planning is put into the context of the environmental systems (soil, water, air, climate, flora and fauna) and discussed with regard to socio-political questions of the future.</td>
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</table>
The main focus of the lecture is on site and project development questions in relation to recycling of industrial wasteland. A semester 2G.

**Site and Project Development**

The lecture consists of several modules. The main focus is on site and project development questions in relation to recycling of industrial wasteland.

**Introduction to the Data Analysis Software R**

Handouts of the lectures and exercises will be distributed. A. Grêt-Regamey, M. J. Van Strien.

**Objective**

Objectives of the lecture are:

1. To illustrate the concept of landscape planning, the economic relevance of landscape and nature in the context of the environmental systems (soil, water, air, climate, flora and fauna).
2. To show landscape planning as an integral information system for the coordination of different instruments by illustrating the aims, methods, instruments and their functions in landscape planning.
3. To point out practical examples of landscape planning in relation to specific industrial wasteland areas.
4. To point out basic information about nature and landscape: Analysis and assessment of the complex interactions between landscape elements, effects of existing and foreseeable utilization of space (nature goods and services and landscape functions).
5. To identify and measure the characteristics of landscape.
6. To learn how to use the instrument of GIS appropriately in landscape planning.

**Content**

In this course, the following topics are discussed:

- Definition of the concept of landscape
- Landscape change
- Landscape planning
- Methods, instruments and aims of landscape planning (politics)
- Socio-political questions of the future
- Environmental systems, IUCN Red List, ecological connectivity
- Urban landscape services
- Practice of landscape planning
- Use of GIS in landscape planning

**Lecture notes**

No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.

**Prerequisites / notice**

The contents of the course will be illustrated in the associated lecture 103-0347-01 U (Landscape Planning and Environmental Systems (GIS Exercises)). An combination of courses is recommended.

---

**103-0337-00L Site and Project Development**

**Abstract**

The main focus of the lecture is on site and project development questions in relation to recycling of industrial wasteland. A semester exercise covers a specific major project and serves as the semester grade (project report and presentation).

**Objective**

Objectives of the lecture are:

1. Get knowledge of comprehensive and multifunctional large-scale projects and their problem areas
2. Get deepened knowledge in selected fields (site analysis, market analysis, project development, cooperation planning, participation processes).
3. Practical orientation, insight into occupational fields
4. Independent acquisition and acquisition of theoretical knowledge

**Content**

The lecture consists of several modules. The main focus is on site and project development questions in relation to recycling of industrial wasteland. Technical presentations, lectured by scientific staff of the division of Planning of Landscape and Urban Systems PLUS as well as guest referees treat different subjects. The subjects are:

- Site and market analysis
- Real estate development
- Project development from the perspective of project developers and investors
- Parking and transportation models
- Cooperative planning, participation processes, mediation

The theory is discussed and illustrated at case studies and exercises. Specific large-scale projects that are currently in the development phase will be discussed, for example the area Sihl- Manegg in Zurich (GreenCity) or the area Alter Pilatusmarkt (Niedfeld) Luzern. For one specific industrial wasteland area the students will develop a vision for a possible redevelopment and a new land-use concept, which will be discussed with experts.

**Lecture notes**

- Handouts of the lectures
- Extracts from relevant scientific articles and theory literature
- Exercise material

Download: http://www.irn.ethz.ch/plus/education

---

**103-0377-00L Introduction to the Data Analysis Software R**

**Abstract**

R is one of the most popular statistical open-source software for data analysis and data modeling. It has proved very useful for a variety of tasks commonly faced by planners, such as data preparation, exploratory analysis, model estimation or graphical display. R is also a programming language providing users with a more flexible and powerful tool for solving more complex problems.

**Objective**

The aim of this course is to provide participants with an introduction to the statistical open-source software R. Students will learn how to read data from files and write data to files, and how these data can be used to plot graphs and maps. Since R is a command-line software, that is, one has to type in text commands at a prompt, rather than just clicking menus and buttons, students will also learn how to write their own functions.

**Content**

Reading data from files
Creating and handling R objects such as matrices, vectors and arrays
Plotting data: histograms, boxplots, scattered plots
Writing data to files
Reading raster and vector data
Writing for- and while-loops
Writing your own functions

**Literature**

"Introduction to R" by W. N. Venables and D. M. Smith
available online at http://cran.r-project.org/doc/manuals/R-intro.pdf

**Prerequisites / notice**

The course will be held in English and no prior knowledge on R is required.

---

**103-0317-00L Sustainable Spatial Development I**

**Abstract**

The lectures impart important knowledge for solving spatial relevant conflicts and problems. Case studies will be used to demonstrate the implementation in practice.

**Objective**

1. To illustrate the concept of landscape planning, the economic relevance of landscape and nature in the context of the environmental systems (soil, water, air, climate, flora and fauna).
2. To show landscape planning as an integral information system for the coordination of different instruments by illustrating the aims, methods, instruments and their functions in landscape planning.
3. To point out practical examples of landscape planning in relation to specific industrial wasteland areas.
4. To point out basic information about nature and landscape: Analysis and assessment of the complex interactions between landscape elements, effects of existing and foreseeable utilization of space (nature goods and services and landscape functions).
5. To identify and measure the characteristics of landscape.
6. To learn how to use the instrument of GIS appropriately in landscape planning.

**Content**

The main focus of the lecture is on site and project development questions in relation to recycling of industrial wasteland. A semester exercise covers a specific major project and serves as the semester grade (project report and presentation).

**Objective**

Objectives of the lecture are:

1. Get knowledge of comprehensive and multifunctional large-scale projects and their problem areas
2. Get deepened knowledge in selected fields (site analysis, market analysis, project development, cooperation planning, participation processes).
3. Practical orientation, insight into occupational fields
4. Independent acquisition and acquisition of theoretical knowledge

**Content**

The lecture consists of several modules. The main focus is on site and project development questions in relation to recycling of industrial wasteland. Technical presentations, lectured by scientific staff of the division of Planning of Landscape and Urban Systems PLUS as well as guest referees treat different subjects. The subjects are:

- Site and market analysis
- Real estate development
- Project development from the perspective of project developers and investors
- Parking and transportation models
- Cooperative planning, participation processes, mediation

The theory is discussed and illustrated at case studies and exercises. Specific large-scale projects that are currently in the development phase will be discussed, for example the area Sihl- Manegg in Zurich (GreenCity) or the area Alter Pilatusmarkt (Niedfeld) Luzern. For one specific industrial wasteland area the students will develop a vision for a possible redevelopment and a new land-use concept, which will be discussed with experts.

**Lecture notes**

- Handouts of the lectures
- Extracts from relevant scientific articles and theory literature
- Exercise material

Download: http://www.irn.ethz.ch/plus/education

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**103-0337-00L Site and Project Development**

**Abstract**

The main focus of the lecture is on site and project development questions in relation to recycling of industrial wasteland. A semester exercise covers a specific major project and serves as the semester grade (project report and presentation).

**Objective**

Objectives of the lecture are:

1. Get knowledge of comprehensive and multifunctional large-scale projects and their problem areas
2. Get deepened knowledge in selected fields (site analysis, market analysis, project development, cooperation planning, participation processes).
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**Content**

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**Lecture notes**

- Handouts of the lectures
- Extracts from relevant scientific articles and theory literature
- Exercise material

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---

**103-0377-00L Introduction to the Data Analysis Software R**

**Abstract**

R is one of the most popular statistical open-source software for data analysis and data modeling. It has proved very useful for a variety of tasks commonly faced by planners, such as data preparation, exploratory analysis, model estimation or graphical display. R is also a programming language providing users with a more flexible and powerful tool for solving more complex problems.

**Objective**

The aim of this course is to provide participants with an introduction to the statistical open-source software R. Students will learn how to read data from files and write data to files, and how these data can be used to plot graphs and maps. Since R is a command-line software, that is, one has to type in text commands at a prompt, rather than just clicking menus and buttons, students will also learn how to write their own functions.

**Content**

Reading data from files
Creating and handling R objects such as matrices, vectors and arrays
Plotting data: histograms, boxplots, scattered plots
Writing data to files
Reading raster and vector data
Writing for- and while-loops
Writing your own functions

**Literature**

"Introduction to R" by W. N. Venables and D. M. Smith
available online at http://cran.r-project.org/doc/manuals/R-intro.pdf

**Prerequisites / notice**

The course will be held in English and no prior knowledge on R is required.

---

**103-0317-00L Sustainable Spatial Development I**

**Abstract**

The lectures impart important knowledge for solving spatial relevant conflicts and problems. Case studies will be used to demonstrate the implementation in practice.
Spatial development deals with the development and the design of our living space. To meet the expectations, the interests and the plans of the different actors, it is needed a planning approach considering the overview of both the actual and future situation. The concept of sustainable development in spatial planning leads necessarily to an efficient management of the resources, especially regarding the resource land. The basics of this important discipline will be the subject of this lecture, which is therefore organised in three parts:
- Inner development
- Integrated spatial and infrastructure development
- Cross-border issues in spatial development

Contents

Tasks of Spatial Planning and development
Issues of local and supra-local interest
Recurring spatial changes, impacts and key figures
Formal and informal instruments and procedures in spatial planning
Spatial Design - Ideas about the future
Reasoning and assessing the situation in spatial planning
Spatial planning as a sequence of decisions and interventions
Process and procedures management
Focus issues - Inner development before external development
Focus issues - Cross-border tasks
Focus Issues - Integrated spatial and infrastructure development

Further information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.

The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such problems are the assessment of a situation, decision making, knowledge, and language. They know the nature of a decision dilemma and maximes, how to deal with it. Especially they learn that the requirement of information for a decision depends upon the preferences of the deciding actor. They are also familiar with difficulties and pitfalls within these contexts and know what can be done against it.

The participants know the interdependencies between the assessment of a situation, decision making, knowledge, and language. They know what can be done against it.

In order to solve problems in spatial planning it is necessary to explore actions and to judge them; finally, one has to argue why a certain option should be preferred to others. Assessments of the situation are the basis for the problems to treat. Specific knowledge, represented in an adequate manner, is required.

The course content of the lecture Landscape Planning and Environmental Systems (103-0347-00 V) will be illustrated.

K. W. Axhausen
A. Grêt-Regamey
S. E. Rabe, A. Strith

The course is composed of a lecture part, providing the theoretical knowledge, and an applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students develop their own models. They understand the most relevant planning methods and will be able to use them.

Lecture notes

A script in German will be provided for the course. The slides are made available.

References to technical literature will be included in the course script. An additional list of literature will be given during the course.

No remarks.

Lecture notes

The slides of the lecture are provided electronically.

References to technical literature will be included in the course script. An additional list of literature will be given during the course.

No remarks.

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No remarks.
Following the insight into historical perspective and contemporary models of governance and planning, the course focuses on the European aspect of spatial development.

**Objective**

Keeping the general aim of exploring the European dimension of spatial planning in mind, the specific course learning objectives are as follows:
- to interpret the history of spatial planning at the transnational scale
- to understand and explain the content of the European spatial policy agenda
- to describe and analyse the role of territorial cooperation in making European spatial development patterns and planning procedures
- to discuss the changing role of planners and evaluate the ways of their engagement in European spatial policy-making

**Content**

- European spatial policy agenda: introduction and basic directives
- governance models
- planning models; collaborative planning model (main concepts & critics)
- post-positivist approach to spatial planning
- transnational spatial planning in Europe; questioning the European spatial planning; spatial development trends in Europe
- EU as a political system: EU institutions & non-EU actors
- planning families in Europe; the European spatial planning agenda
- spatial planning strategies and programmes on territorial cooperation
- the notion of planning culture and planning system; planning cultures in Europe
- basic characteristics of planning systems in Europe
- the relevance of transnational cooperation for spatial planning
- European transnational initiatives: CODE 24 (Rotterdam-Genoa), Orient/east-Med corridor (Hamburg-Athens), Danube region

**Prerequisites / notice**

- Basic GIS skills are recommended. A brief introduction to GIS will be given in the first exercise.

**Recommended Electives of Bachelor Degree Programme**

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<th>Number</th>
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<tr>
<td>101-0439-00L</td>
<td>Introduction to Economic Analysis - A Case Study</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>K. W. Axhausen, R. Schubert</td>
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</table>
The goal of this course is to engage students in a multidisciplinary collaboration to tackle real world problems. Following a design thinking approach, students will work in teams to solve a set of design challenges that are organized as a one-week, a three-week, and a final six-week project in collaboration with an external project partner.

### Content

- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.
- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Design Thinking: Human-Centred Solutions to Real World Challenges
- Due to didactic reasons, the number of participants is limited to 30.

### Prerequisites / notice

Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

### Electives ETH Zurich

**Course Catalogue of ETH Zurich**

**Seminar Work**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**

Introduction to general scientific working methods and skills in the core fields of geomatics. It includes a literature study, a review of one of the articles, a presentation and a report about the literature study.

**Objective**

Learn how to search for literature, how to write a scientific report, how to present scientific results, and how to critically read and review a scientific article.
A list of themes for the literature study are made available at the beginning of the semester. A theme can be selected based on a moodle.

Agreement with one of the responsible Professors is necessary.

### Interdisciplinary Project Work

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0298-02L</td>
<td>Interdisciplinary Project</td>
<td>O</td>
<td>12</td>
<td>24A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract: Working on a concrete interdisciplinary task in Geomatics.

Objective: Promote independent, structured and scientific work in an interdisciplinary context; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

Content: The project work is supervised by a professor. Students can choose from different subjects and tasks. The project can be carried out in German upon mutual agreement between supervisor and student.

### GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-BAUG.

- see GESS Science in Perspective: Type A: Enhancement of Reflection Capability
- see GESS Science in Perspective: Language Courses ETH/UBZH

### Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0009-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>24</td>
<td>47D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

Abstract: Before starting the Master's thesis, students must have performed the Bachelor's degree; fulfilled all specified admission conditions, if any; acquired at least 90 credits in the Master's programme, including 12 credits in the area of the interdisciplinary project.

Objective: To work independently and to produce a scientifically structured work.

Content: The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

### Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0115-AAL</td>
<td>Geodetic Metrology II</td>
<td>E-</td>
<td>5</td>
<td>4R</td>
<td>A. Wieser</td>
</tr>
</tbody>
</table>

Abstract: Advanced topics in geodetic metrology with focus on instrumental and methodic aspects for applications with higher accuracy demands.

Objective: The students acquire enhanced knowledge regarding the operating mode, the application and the limitations of modern geodetic standard instruments. They will be able to properly select, test and apply these instruments for geodetic tasks with higher accuracy requirements. They will get acquainted with the typical workflow from the preparation of the field works to the digital or plotted plan. Finally, the students will be introduced to specific geodetic tasks related to construction and civil engineering.

Content: - The geomatics workflow
- Propagation of light in the atmosphere
- The modern total station
- Terrestrial Laserscanning
- Digital levels
- Field tests
- Traverses
- Trigonometric leveling
- Precision leveling
- Route planning and transition curves
- Earthworks: Area and cubature

Lecture notes: Slides and documents for enhanced study and further reading will be provided online.


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0126-AAL</td>
<td>Geodetic Reference Systems</td>
<td>E-</td>
<td>3</td>
<td>3R</td>
<td>M. Meindl</td>
</tr>
</tbody>
</table>

Abstract: Fundamentals and theory of geodetic reference systems and frames. Introduction to current international systems as well as to systems for the Swiss national geodetic survey.

Objective: Provision of fundamental knowledge and theory to get familiar with the applications of geodetic reference systems. Special emphasis will be placed on international global systems as well as on the systems of the Swiss national geodetic survey.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0132-AAL</td>
<td>Geodetic Metrology Fundamentals</td>
<td>E-</td>
<td>6</td>
<td>4R</td>
<td>A. Wieser</td>
</tr>
</tbody>
</table>

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Prerequisites / Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0414-AAL</td>
<td>Transport Planning (Transportation I)</td>
<td>3</td>
<td>2R</td>
<td></td>
</tr>
<tr>
<td>103-0153-AAL</td>
<td>Cartography II</td>
<td>5</td>
<td>4R</td>
<td>L. Hurni</td>
</tr>
<tr>
<td>103-0184-AAL</td>
<td>Higher Geodesy</td>
<td>5</td>
<td>4R</td>
<td>M. Rothacher</td>
</tr>
<tr>
<td>103-0214-AAL</td>
<td>Cartography I</td>
<td>5</td>
<td>4R</td>
<td>L. Hurni</td>
</tr>
<tr>
<td>103-0233-AAL</td>
<td>GIS I</td>
<td>3</td>
<td>2R</td>
<td>M. Raubal</td>
</tr>
</tbody>
</table>

**Abstract**
- Introduction to the most important sensors, operation and calculation methods of Geodetic Metrology
- Getting to know the most important sensors, operation and calculation methods of Geodetic Metrology
- Overview on the different domains of geodetic metrology
- Geodetic instruments and sensors
- Determination of 3D-coordinates with GNSS, total station and levelling
- Calculation methods of geodetic metrology
- Survey and staking-out methods

**Lecture notes**
- Slides and additional material used in the associated regular course Geodätische Messtechnik GZ (in German) are provided in electronic form.

**Literature**
- Overview on the different domains of geodetic metrology
- Acquire basic knowhow about communication with spatial information by using plans and maps, about the most important design rules and production methods for map graphics.
### Content
- Modelling of spatial information
- Geometric and semantic models
- Topology & metrics
- Raster and vector models
- Databases
- Applications
- Labs with GIS software

### Literature

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Prerequisites / Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0234-AAL</td>
<td>GIS II Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>5</td>
<td>4R</td>
<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
</tr>
<tr>
<td>103-0253-AAL</td>
<td>Geoprocessing and Parameter Estimation Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>5</td>
<td>4R</td>
<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
</tr>
<tr>
<td>103-0254-AAL</td>
<td>Photogrammetry Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>5</td>
<td>4R</td>
<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
</tr>
<tr>
<td>103-0255-AAL</td>
<td>Geodata Analysis Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>2</td>
<td>4R</td>
<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
</tr>
<tr>
<td>103-0274-AAL</td>
<td>Image Processing Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>3</td>
<td>2R</td>
<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
</tr>
</tbody>
</table>
The following topics will be covered in the course:

- Image segmentation
- Properties of digital images
- Signal processing/Sampling
- Image enhancement
- Image restoration: Spatial domain
- Image restoration: Fourier domain
- Color/Demosaicing
- Image compression
- Feature extraction
- Texture analysis

Lecture notes
A script will be provided as PDF files on the lecture website.

Literature
We suggest the following textbooks for further reading:

Rafael C. Gonzalez, Richard E. Woods
Digital Image Processing
ISBN: 013168728X

Rafael C. Gonzalez, Steven L. Eddins, Richard E. Woods:
Digital Image Processing Using MATLAB
Prentice Hall, 2003
ISBN: 0130085197

Prerequisites / notice
The course is accompanied by programming assignments, that need to be completed in order to pass the semester performance.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0313-AAL</td>
<td>Planning I</td>
<td>5</td>
<td>R</td>
<td>G. Nussbaumer</td>
</tr>
<tr>
<td>103-0325-AAL</td>
<td>Planning II</td>
<td>5</td>
<td>R</td>
<td>B. Scholl</td>
</tr>
<tr>
<td>103-0435-AAL</td>
<td>Landmanagement</td>
<td>5</td>
<td>R</td>
<td>G. Nussbaumer</td>
</tr>
<tr>
<td>252-0846-AAL</td>
<td>Computer Science II</td>
<td>4</td>
<td>R</td>
<td>F. O. Friedrich</td>
</tr>
</tbody>
</table>

Abstract
The lecture introduce into the main-features of spatial planning. Attended will be the themes planning as a national responsibility, instruments of spatial planning, techniques for problem-solutions in spatial planning and the swiss concept for regional planning.

Objective
- To get to know the interaction between the community and our living space and their resulting conflicts.
- Link theory and practice in spatial planning.
- To get to know instruments and facilities to process problems in spatial planning.

Content
The self-study course compromises the following readings:
- Lynch, Kevin: «The Image of the City»
- Alexander, Christopher et al.: «A Pattern Language»
- Mikoleit, Anne and Pürckhauer, Moritz: «Urban Code»
- «SIDAIA - Spatial and Infrastructure Development: An Integrated Approach»

The graded semester performance comprises a condensed paper to be written by the student reflecting both the literature read as well as exemplarily applying the knowledge gained from the literature by independently exploring the two city quarters.

Lecture notes
cf. content

Literature
cf. content

Abstract
The lecture imparts methodological and instrumental fundamentals for spatial planning and will be exemplified by exploring two Zurich city quarters.

Objective
Spatial planning is concerned with the foresighted design of the built and un-built environment. Starting points are spatially relevant problems that need to be explored, clarified and solved. The cornerstone of the course is formed by an independent exploration by the student of two Zurich city quarters that involves investigating specific spatially relevant conditions, recognizing regularities and relevant problems.

Content
The self-study course compromises the following readings:
- Lynch, Kevin: «The Image of the City»
- Alexander, Christopher et al.: «A Pattern Language»
- Mikoleit, Anne and Pürckhauer, Moritz: «Urban Code»
- «SIDAIA - Spatial and Infrastructure Development: An Integrated Approach»

The graded semester performance comprises a condensed paper to be written by the student reflecting both the literature read as well as exemplarily applying the knowledge gained from the literature by independently exploring the two city quarters.

Lecture notes
cf. content

Literature
cf. content

Abstract
Spatial planning on the Commune level with focus on the special land use management. Land re-allocation as an instrument of spatial planning; specific explanations for land re-allocations in rural regions and in construction zones. Land marketing: the view of investors.

Objective
Getting knowledge in spatial planning and land re-allocation as an interactive process.

Content
Getting knowledge in spatial planning and land re-allocation as an interactive process.

Abstract
Introduction to programming in Java. Procedural foundations of programming and outlook to object oriented programming. Variables, types, assignments, control structures (branch, loop), data structures, algorithms, line graphics, graphical user interface. Writing small programs. Working with a professional programming environment (Eclipse).

Objective
The students will be able to write simple programs and to modify existing programs.

Content
This course offers an introduction to variables, control structures (branch, loop), algorithms and data structures, as well as an outlook to modularisation and object oriented techniques.

In the exercises students train programming skills (in the programming language JAVA). Students can solve the exercises on their own laptop or in the computer labs at ETH. The software used in this course runs on MS Windows, MacOS X and Linux.
**Prerequisites / notice**

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Abstract**

Basic topics in classical as well as modern physics, interplay between basic research and applications.

**Content**

Electrodynamics, Thermodynamics, Quantum physics, Waves and Oscillations, special relativity

**Literature**


Hans J. Paus, Physik in Experimenten und Beispielen, Carl Hanser Verlag München Wien (als unterrichtsbegleitendes und ergänzendes Lehrbuch)

---

**Prerequisites / notice**

Knowledge of elementary calculus

**Abstract**

Introduction to Linear Algebra and Numerical Analysis for Engineers. This reading course is based on chapters from the book "Introduction to Linear Algebra" by Gilbert Strang (SIAM 2009), and "A first Course in Numerical Methods" by U. Ascher and C. Greif (SIAM, 2011).

**Objective**

To acquire basic knowledge of Linear Algebra and some aspects of related numerical methods and the ability to apply basic algorithms to simple problems.

**Content**

* Linear systems of equations: Gaussian elimination, row echelon form, theory about existence and uniqueness of solutions (Strang Ch. 2 and 3.4)
* Mathematical modelling by linear systems (e.g. networks, trusses) (Strang, parts of Ch. 8)
* Column space, null space and rank of matrices (Strang 3.2, 3.3)
* Linear combinations, linear (in)dependence, bases, dimension theorem for matrices (Strang 3.5, 3.6)
* Inner product, orthogonality, length in Euclidean space (Strang 4.1, 4.2)
* Least squares solutions and orthogonalization (Gram-Schmidt and QR) (Strang 4.3, 4.4)
* Linear mappings, matrix representation and change of basis (Strang Ch. 7)
* Determinants and diagonalization of matrices (eigenvalues and eigenvectors) (Strang 6.1, 6.2, 6.5, 6.6)
* Diagonalization applied to linear differential and difference equations. (Strang 6.3)
* Numerical methods for solving linear systems of equations (Ascher/Greif 5.1, MATLAB Documentation of ')
* Interpolation with polynomials and splines (Ascher/Greif Ch. 10 and 11)

**Literature**


---

**Prerequisites / notice**

Mathematics as a tool to solve engineering problems. Mathematics as a tool to solve engineering problems, mathematical formulation of problems in science and engineering. Basic mathematical knowledge of an engineers.

**Content**

Complex numbers.

Calculus for functions of one variable with applications. Simple Mathematical models in engineering.

### Literature

Textbooks in English:

Textbooks in German:
- M. Akveld, R. Sperb: Analysis I, vdf
- M. Akveld, R. Sperb: Analysis II, vdf
- L. Papula: Mathematik für Ingenieure und Naturwissenschaftler, Vieweg Verlag
- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag

### 406-0603-AAL

**Stochastics (Probability and Statistics)**

<table>
<thead>
<tr>
<th>E-</th>
<th>4 credits</th>
<th>9R</th>
<th>M. Kalisch</th>
</tr>
</thead>
</table>

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

### Abstract

Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

### Objective

The objective of this course is to build a solid foundation in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

### Content

- From "Statistics for research" (online)
  - Ch 1: The Role of Statistics
  - Ch 2: Populations, Samples, and Probability Distributions
  - Ch 3: Binomial Distributions
  - Ch 6: Sampling Distribution of Averages
  - Ch 7: Normal Distributions
  - Ch 8: Student's t Distribution
  - Ch 9: Distributions of Two Variables

- From "Introductory Statistics with R (online)"
  - Ch 1: Basics
  - Ch 2: The R Environment
  - Ch 4: Descriptive statistics and tables
  - Ch 5: One- and two-sample tests
  - Ch 6: Regression and correlation

### Literature

- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  - From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435

  - From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/

### Geomatic Engineering Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

### ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Lectures and Exercises

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>862-0050-00L</td>
<td>History and Philosophy of Knowledge: Goals, Methods and Work Techniques</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>N. El Kassar, N. Guettler, M. Hampe, F. Hupfer, C. Jany, B. Schlör, M. Wulz</td>
</tr>
<tr>
<td></td>
<td>Only for History and Philosophy of Knowledge MSc.</td>
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<tr>
<td></td>
<td>This lecture is important as an Introduction to the Master Programme</td>
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<tr>
<td></td>
<td>Abstract</td>
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</tr>
<tr>
<td></td>
<td>The interdisciplinary lecture series are exclusively addressed to the students of the HPK-M.A. programme. They provide an insight into all the disciplines which participate in the M.A. programme and their specific demands, approaches, problems and techniques. Subsequent to the lectures, there will be an opportunity to discuss difficulties occurring within the procedures of thesis-writing. The series should provide and secure a substantial, methodological and formal orientation within the disciplines taught in the M.A.-program.</td>
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<tr>
<td></td>
<td>Objective</td>
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<tr>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Dates: Thursday, 10-12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>851-0125-18L</td>
<td>Self-Ownership - Philosophical and Juridical Perspectives</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Hagner</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<tr>
<td></td>
<td>Rights in Objects are founded by an inalienable Self-Ownership. These Idea ist central for personal rights. We speak of my body, my genes, my name, my portrait, my ideas oder ways of expression.</td>
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</tr>
<tr>
<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>Participants will make acquaintance with founding texts of the natural rights property concept (John Locke). They will see the connection between inalienable self-ownership, prohibition of slavery, derivative commercial rights and modern personal rights. They will learn about the problems of self-ownership today concerning property in one's body and intellectual property. Critical alternatives to the property paradigm will be discussed.</td>
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<tr>
<td></td>
<td>Participants will have the opportunity to gain access to unfamiliar texts from the philosophical tradition and to see their relevance today. They experience the consequences of a certain use of concepts and orient themselves in current bioethical, juridical and political discussions.</td>
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</tr>
<tr>
<td></td>
<td>Content</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Texts by Locke, Nozick, Christman, Otsuka, Rasmussen, Schneider, Stirmer, Fichte and Forschner. Founding of property right in self-ownership (Locke), revival of this concept in Nozick and his egalitarian critics. Critique of the concept of self-ownership related to property in one's body. Looking back to the personal self-relatedness that comes up again in Intellectual Property and in modern personal rights.</td>
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</tr>
<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Text, Seminarplan und Literaturliste in ILIAS Lehrdokumentenablage.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>851-0157-00L</td>
<td>Mind and Brain</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. Hagner</td>
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<td>Abstract</td>
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<td>In the last 2500 years, the mind-brain relationship has been articulated in various ways. In these lectures, I will explore the scientific and philosophical aspects of this relationship in the context of relevant cultural, historical and technological processes, with a focus on the modern neurosciences, but I will also discuss works of art and literature.</td>
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<td>By the end of this lecture, students should be familiar with essential positions in the scientific and philosophical treatment of questions relating the mind to the brain. It should also become clear that some of the most relevant problems in current neurosciences have a long history.</td>
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<td>According to a myth, the ancient Greek philosopher Democrit dissected animals, because he was in search of the seat of the soul. Current neuroscientists use neuroimaging techniques like functional magnetic-resonance-tomography in order to localize cognitive and emotional qualities in the brain. Between these two dates lies a history of 2500 years, in which the relationship between the mind and the brain has been defined in various ways. Starting with ancient and medieval theories, the lecture will have its focus on modern theories from the nineteenth century onward. I will discuss essential issues in the history of the neurosciences such as localization theories, the neuron doctrine, reflex theory, theories of emotions, neurocibernetics and the importance of visualizing the brain and its parts, but I will also include works of art and literature.</td>
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<td>851-0549-00L</td>
<td>WebClass Introductory Course History of Technology</td>
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<td>G. Hürlimann</td>
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<td>Number of participants limited to 100.</td>
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<td>WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.</td>
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<td>WebClass Einführungskurs Technikgeschichte ist eine webgestützte Einführung in die Technikgeschichte. Technikgeschichte untersucht Angebote technischer Entwicklungen, die in bestimmten historischen Kontexten entstanden und von sozialen Gruppen oder ganzen Gesellschaften als Möglichkeit sozialen Wandels wahrgenommen, ausgehandelt und schliesslich genutzt oder vergessen wurden.</td>
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<td>Lecture notes</td>
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<td>851-0125-41L</td>
<td>Introduction Into Philosophy of Technology</td>
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<td>2V</td>
<td>O. Müller</td>
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<td></td>
<td>Particularly suitable for students of D-ITET, D-MATL, D-MAVT</td>
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<td>This lecture is important as an Introduction to the Master Programme</td>
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<td>Introduction Into Philosophy of Technology</td>
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**Data:** 06.11.2018 12:57  
**Autumn Semester 2016**  
**Page 723 of 1571**
Abstract
Since antiquity philosophy reflects about and evaluates technology. The technical developments in the 19th and 20th century have led to a
autonomous philosophy of technology, which had become important also for other philosophical disciplines (e.g. in Heidegger's
philosophy).

Objective
The course gives an overview on the main schools in the philosophy of technology. Students should learn to analyse and evaluate different
philosophies of technology (compensation, objectification, externalisation). For credit point a critical protokoll is to be written.

851-0609-06L
Governing the Energy Transition
W 2 credits 2V T. Schmidt

Number of participants limited to 130.

Primarily suited for Master and PhD level

Abstract
This course addresses the role of policy and its underlying politics in the transformation of the energy sector. It covers historical, socio-
economic, and political perspectives and applies various theoretical concepts to specific aspects of governing the energy transition.

Objective
- To gain an overview of the history of the transition of large technical systems
- To recognize current challenges in the energy system to understand the theoretical frameworks and concepts for studying transitions
- To demonstrate knowledge on the role of policy and politics in energy transitions

Content
Climate change, access to energy and other societal challenges are directly linked to the way we use and create energy. Both the recent
United Nations Paris climate change agreement and the UN Sustainable Development Goals make a fast and extensive transition of the
energy system necessary.

This course introduces the social and environmental challenges involved in the energy sector and discusses the implications of these
challenges for the rate and direction of technical change in the energy sector. It compares the current situation with historical socio-
technical transitions and derives the consequences for policy-making. It then introduces theoretical frameworks and concepts for studying
innovation and transitions. It then focuses on the role of policy and policy change in governing the energy transition, considering the role
of political actors, institutions and policy feedback.

The course has a highly interactive (seminar-like) character. Students are expected to actively engage in the weekly discussions and to
give a presentation (15-20 minutes) on one of the weekly topics during that particular session. The presentation (30%) and participation in
the discussions (20%) will form one part of the final grade, the remaining 50% of the final grade will be formed by a final exam.

Lecture notes
A reading list will be provided via moodle.ethz.ch at the beginning of the semester.

Literature
A detailed course description and session plan will be available from 15 Sept 2013 onwards at http://www.gmw.ethz.ch/education

Prerequisites / notice
This course is particularly suited for students of the following programmes: MA Comparative International Studies; MSc Energy Science &
Technology; MSc Environmental Sciences; MSc Management, Technology & Economics; MSc Science, Technology & Policy; ETH & UZH
PhD programmes.

851-0144-19L
Philosophy of Time
W 3 credits 2V N. Sieroaka

Particularly suitable for students of D-BIOL, D-INFK, D-
MATH, D-PHYS

Abstract
This course provides an introduction to philosophical issues surrounding the concept of time. We will treat topics such as: the existence of
past, present, and future; the possibility of time travel; the constitution of time consciousness and its possible neurophysiological
counterparts; temporal biases in the conduct of our lives; responsibility to future and past generations.

Objective
By the end of the course students are able to describe and compare different theories and concepts of time (physical time, perceptual time,
historical time ... ). They are able to identify and examine issues concerning time as they occur in various philosophical subdisciplines -
especially in philosophy of science, philosophy of mind, metaphysics, and ethics. Students are in a position to critically discuss and
evaluate the repercussions of these issues in broader scientific and social contexts.

Part of the course reflects on methods and contents from physics, neuroscience/cognitive science, and logic.

851-0125-61L
What is the Value of Truth?
W 3 credits 2G L. Wingert

Abstract
It is useful to know which fellowships are available or to know the causes of frequent occurrence of extreme weather. These truths are of
instrumental value, and it is also intrinsically good to know the truth, e.g. to know that there are gravitational waves? And which is the role of
truth in our lives? The course will deal with such philosophical questions.

Objective
1. Teilnehmer des Kurses werden mit verschiedenen, einflussreichen philosophischen Antworten und ihren Begründungen auf die Frage
bemachtet: Hat die (erkannte) Wahrheit einen Wert? (U.a. von William James, von Friedrich Nietzsche und Bernard Williams.)

2. Auch soll eine überlegte Meinung gewonnen werden zu dem Verhältnis von zweckfreier Grundlagenforschung und nützlichen
Anwendungen in den Wissenschaften.

3. Ebenso soll ein besseres Urteil gebildet werden darüber, welche existenzielle Rolle die Suche nach Wahrheiten in unserem persönlichen
Leben hat.

851-0125-62L
On the Relation Between Nature and Social Culture in W 3 credits 2G L. Wingert
Human Cognition and Action

Abstract
How should we human beings understand ourselves according to our best knowledge about us, the social world, human history and
nature? What are the relationships between biological and socio-cultural determinants of our thinking and doing? Michael Tomasello,
psychologist, and social philosopher, has answered these questions in a thought provoking way. His answers will be studied and
examined.

Literature

851-0101-18L
"Bollywood and Beyond" - A Cultural History of Indian W 3 credits 2V H. Fischer-Tiné
Cinema in the 20th Century

Abstract
The Indian film industry has been around for 100 years and is one of the richest and mist variagated of the world. The lecture reconstructs
the historical development of Indian cinema and uses it as a lens through which cultural, social and politcal change in the subcontinent can
be explored.

Objective
The objectives of this course are three-fold. For one, the participants shall learn to question aesthetic cainties and received modes of
perception of cinematographic art. Secondly they will be acquainted with the huge potential of films as a historical source to grasp
processes of social and cultural change. Besides, the reconstruction of the international career of a specific variety of art and entertainment
will also raise important questions of cultural globalisation and consumerism. As a side-effect, a sit were, the students will also be
provided with important insights into the chequered history of the Indian subcontinent in during the course of the 20th century.

Literature
Vrdik, Jyotika, The Cinematic IMagination: Indian Popular Film as Social History, New Brunswick, NJ and London: Rutgers University

Prerequisites / notice
A reading list will be provided via moodle.ethz.ch at the beginning of the semester.
In this course we will examine fundamental questions of epistemology, e.g. What is knowledge? How are we to conceive of perception? How we understand Mathematics is probably strongly influenced by the Mathematics lessons we participated in during our school days.

The lecture series will present philosophical problems of theoretical mathematics in the 20th century and will discuss the consequences of

Introduction to Epistemology

On the one hand modells of machines had a heuristical value in research on man, e.g. in Harvey's discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these modells were always criticised, sometimes polemically, because they are supposedly not adequate for man.

This lecture provides a general introduction to literary theory and presents the important theories dealing with knowledge and its role in and as literature.


851-0125-63L Images of Mathematics

Particularly suitable for students of D-MATH

The lecture series "Images of Mathematics" deals with the formalization of the objects and the logical language of mathematics from Hilbert to Gödel and considers its consequences in view of our conception of mathematical practice and knowledge, the limits of calculability and computability in mathematics, and the relation between the logical proof procedures and the involved intuitive aspects.

The lecture series "Images of Mathematics" deals with a few moments in the history of the scientific discipline since the middle of the 19th century when the image of mathematics changed. In particular, it focuses on the consequences of the fact that in the 19th century mathematics started to not only reflect on their own conceptual and methodological foundations in a general manner (which had been done since the dawn of mathematics and was especially a philosophical task), but to formalize them in a strict, mathematical way: the objects of mathematics, its logical and its proof procedures. Through Cantor’s set theory, the mathematical treatment of logic since Boole and especially through Frege and the formalization of its axioms in a wide ranging discussion involving Zermelo, Fraenkel and others, this self-referexive stance came to the fore.

Yet, the deeper mathematics dug into its foundations, the more radical the problems became. Finally, the optimistic Hilbert program of laying the foundation of mathematics within mathematics and of proving its own consistency as well as its completeness contributed to clarifying of the foundation of mathematics primarily insofar as it was doomed to failure. Gödel proved his famous incompleteness theorems and thereby dismissed at the same time the formalist attempt to reduce mathematical truth to logical provability. His work resulted in detailed insights in the precariousness of the foundation of mathematics and further numerous of productive consequences within mathematics.

Moreover, Gödel's theorems open many far-reaching and intriguing questions in view of our image of mathematics, questions concerning the conception of mathematical practice and knowledge, the limits of calculability of mathematics and the possible role of computability and machines in mathematics, the relation between the logical proof procedures and the involved intuitive aspects. In short, the image of mathematics is not as static as we sometimes expect it to be, it was radically redrawn by the mathematicians of the 20th century and has since then again been open to diverging interpretations.

851-0125-51L Man and Machine

Particularly suitable for students of D-CHAB, D-HEST, D-MAYT, D-MATH

The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different modells of machines will be important here: the clockwork, the steam engine and the computer.

On the one hand modells of machines had a heuristical value in research on man, e.g. in Harvey's discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these modells were always criticised, sometimes polemically, because they are supposedly not adequate for man.

Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

851-0300-85L The Knowledge of Literature. An Introduction

This lecture provides a general introduction to literary theory and presents the important theories dealing with knowledge and its role in and as literature.

Students are introduced to the various approaches and methods of literature studies and gain an overview of literary theory.

This lecture has two aims: Firstly, it serves as a general introduction into the field of literary theory (thereby looking into "knowledge about literature"). Secondly, there will be a special emphasis on recent theoretical approaches that take seriously literature and knowledge as one of its components (thus investigating the "knowledge of literature"). Even though traditional criticism disagrees, a number of recent approaches, based on literature and culture studies, hold that literature is not to be conceived of as standing in opposition to the world and the classificatory system of the academic disciplines, particularly the sciences (e.g. Foucauldian discourse analysis and New Historicism).

Instead, these approaches understand literature in terms of its epistemological forms and functions. Thus, the main thesis is that literature actively participates in the constitution and formation of knowledge. Literature itself generates models of knowledge, sometimes with critical or even utopian intentions. Moreover, it draws attention to the fundamental role of order and representation (systematization, narrative rendering, linguistic and pictorial representation) in both humanities and sciences.

851-0125-60L Introduction to Epistemology

This course will we examine fundamental questions of epistemology, e.g. What is knowledge? How are we to conceive of perception? Which beliefs are rational and justified? How do we acquire knowledge? By discussing a selection of seminal philosophical texts we will study fundamental epistemological theories.
Objective
- conceptions of fundamental epistemological concepts
- sensitivity to epistemological questions
- capacity to reflect epistemological theories
- capacity to discuss epistemological theories
- reading philosophical texts (including English texts)

### Seminars

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<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>851-0129-00L</td>
<td>Writing for Others - Science and Public</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>U. J. Wenzel</td>
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<tr>
<td>Abstract</td>
<td>Learning to write texts, that can present topics from the sciences to an interested public (in newspapers, non-specialist journals but also in papers for non-specialists in an academic context); to gain insights into the cultural, historical and philosophical contexts of science and the public.</td>
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<td>Objective</td>
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<td>Content</td>
<td>Practical exercises in writing articles for the feature pages of newspapers will be combined with the theoretical work on topics relevant for the historical, sociological and philosophical aspects of writing for others.</td>
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<td>Prerequisites / notice</td>
<td>Voraussetzungen: Die Bereitschaft, sich auf ein Projekt mit experimentellem Charakter einzulassen. GUTE BEHERRSCHUNG DER DEUTSCHEN SPRACHE.</td>
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Die Teilnehmerzahl ist begrenzt. SCHRIFTLICHE ANMELDUNG erforderlich (bis 31. August): uwe.justus.wenzel@nzz.ch

| 701-0001-00L | Readings in Environmental Thinking | W    | 3    | 2S    | J. Ghaouli, G. Hirsch Hadorn, A. Patt |
| Abstract | This course introduces students to foundational texts that led to the emergence of the environment as a subject of scientific importance, and shaped its relevance to society. Above all, the course seeks to give confidence and raise enthusiasm among students to read more widely around the broad subject of environmental sciences and management both during the course and beyond. |
| Objective | The course will provide students with opportunities to read, discuss, evaluate and interpret key texts that have shaped the environmental movement and, more specifically, the environmental sciences. Students will gain familiarity with the foundational texts, but also understand the historical context within which their academic and future professional work is based. More directly, the course will encourage debate and discussion of texts and their context is studied from both the original perspective as well as the modern context. In doing so, students will be forced to consider and justify the current societal relevance of their work. |
| Content | The course will be run as a book reading club. The first session will provide a short introduction as to how to explore a particular text (that is not a scientific paper) to identify the key points for discussion. Thereafter, in each week a text (typically a chapter from a book or a paper) considered to be seminal or foundational will be assigned by a course lecturer. The lecturer will introduce the selected text with a brief background of the historical and cultural context in which it was written, with some additional biographical information about the author. He/she will also briefly explain the justification for selecting the particular text. The students will read the text, with two to four students (depending on class size) being assigned to prepare for the next session. Presentation of the text requires the students to prepare by, for example: |
| Discussions | Discussions might also encompass films or other forms of media and communication about nature. |

| 851-0145-05L | Narratives of Health and Illness | W    | 3    | 2S    | S. Baier |
| Number of participants limited to 30 | Particularly suitable for students of D-HEST | |
| Objective | Ziel der Veranstaltung ist es, eine eigenständige kritische Perspektive auf Erzählungen von Gesundheit und Krankheit zu ermöglichen. Im Seminar werden daher unterschiedliche Arten von aktuellen Texten und Materialien zur Rolle von medizinischen Narrativen kritisch miteinander diskutiert. |

| 851-0148-04L | Cyclical time | W    | 3    | 2S    | T. Böhm |
| Abstract | The idea of cyclical time is found in ancient pieces of wisdom (Pythagoreans, Plato, Buddhism) as reincarnation or memory, but also in Nietzsche as eternal return, in Deleuze as repetition, in Freud as repetition compulsion. We investigate the concept of repetition in combination with difference as a positive mode of thinking change. |
| Objective | Understanding of the various forms and functions of repetition on the basis of texts by Plato (anamnesis), Freud (repetition compulsion), Kierkegaard (narration), Nietzsche (eternal return as cosmological and ethical principle), Deleuze (time synthesis and repetition of the future), Poincaré's theorem of recurrence. |

| 851-0144-20L | Philosophical Aspects of Quantum Physics | W    | 3    | 2S    | N. Sieroka, R. Renner |
| Particularly suitable for students of D-CHAB, D-PHYS | |

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 726 of 1571
851-0301-05L  Beginnings
Number of participants limited to 25
3 credits  2S  C. Jany

Abstract
This course provides an introduction to philosophical issues surrounding quantum physics. In particular, we will examine different interpretations of quantum mechanics (such as the many-world interpretation) and the transition between the quantum and the classical physical realm (here phenomena such as decoherence will be highlighted).

Objective
By the end of the course students are able to describe and compare different interpretations of quantum mechanics. They are able to identify and examine issues concerning these different interpretations and issues concerning the transition between quantum and classical descriptions in physics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific contexts.

851-0306-05L  Literature and Technology - Simulations, Prototypes, Machines
Particularly suitable for students of D-ITET, D-MAVT, D-MATL
3 credits  2S  E. Edelmann-Ohler

Abstract
“All beginnings are difficult,” goes the saying, “but without them there wouldn’t be an end.” However, what makes beginnings so difficult? What kind of action is that? Which knowledge does it presuppose? And what would a beginning say about the end? We will pursue these questions by reading sacred, philosophical, literary, and scientific texts that, each in its own way, make a beginning.

Objective
- thorough reading and critical analysis of the texts
- reflection upon the conditions and practice of beginnings in terms of their epistemology and rhetorical strategy (i.e. as an intellectual and literary operation)
- consider the cultural and historical function of fictions that tell of origins, such as cosmological myths, foundationalist philosophy, or poetic incantations

Literature
Myths of Creation and First Origins (Genesis und Gospel of St. John, Theogony, Upanishads); philosophy (Fichte, Hegel); literature and poetry (Wieland, Hölderlin, Novalis, Wordsworth, Melville, Richard Wagner, Beckett). For an introduction, see Wolfgang Iser, Emergenz: Nachgelassene und verstreut publizierte Essays (Konstanz 2013).

Prerequisites / notice
readings partly in English

851-0551-03L  Postal Knowledge and the History of Digital Societies
Particularly suitable for students of D-ARCH, D-BAUG, D-HEST, D-INFk, D-ITET, D-MAVT
3 credits  2S  D. F. Zetti

Abstract
In the second half of the 20th century, postal services have dramatically changed. Communication today is computer-based. The lecture offers problem oriented insights into this sociotechnical process of translation.

Objective
Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication.

Content

851-0157-66L  Who was Sigmund Freud?
3 credits  2S  M. Hagner

Abstract
This seminar is devoted to the introduction into the ideas and concepts of one of the most influential thinkers of the 20th century. We will read selected texts by Freud for getting an overview over his medical, psychological and cultural thinking.

Objective
30 years ago it would have been bizarre to ask the question: Who was Sigmund Freud? The influence of psychoanalysis on twentieth century thinking was taken for granted even by those ones who rejected Freud's ideas. In contrast, the question today would be: What are Freud's central theories? We will tackle this question in the seminar and reconstruct Freud's thinking from his early medical writings to his major works.

Prerequisites / notice
students need to read the texts in advance. The Vorlesung offers an introduction to the seminar and reconstruct Freud's thinking.

851-0127-28L  Death - The Secret Problem of Life
3 credits  2S  H. Wiedebach

Abstract
No detective novel without a corpse, no religion without knowledge about death and life, no large transplantation of an organ without certificate for the donor's death. Is a dead person always a corpse? - Death is part of life and yet stands simultaneously in opposition to it. We cling to life and nonetheless wish to have the option to commit suicide. Do we know what we really want in that case?

Objective
Discussion of 1) several conceptions of death in history, 2) determination of death in a medical sense (brain-death, etc.). 3) The search for a personal view about life and death. 4) The practice of a precise manner of speaking based on reflection.

Literature
Texte als Diskussionsgrundlage werden zu Beginn des Semesters genannt bzw. als PDF unter "Lernmaterialien" veröffentlicht. 4) The search for a personal view about life and death. 4) The practice of a precise manner of speaking based on reflection.

Prerequisites / notice
Leistungsnachweise der Studenten
- Es besteht Anwesenheitspflicht. Einmaliges Fehlen ist möglich mit Entschuldigung. Als Ersatz die Sitzung wird eine 4-seitige Darstellung des diskutierten Textes geliefert.
- Ab dem 2. Seminartermin erfolgt im Voraus pro Sitzung (d.h. insgesamt 6mal) eine 2-seitige Darstellung bzw. Stellungnahme zu einem vorgegebenen Text.
- Die 2-seitigen Darstellungen müssen bis Dienstag Abend in der Woche vor der nächsten Sitzung vorliegen, damit wir Zeit haben, sie zu lesen.
- Statt einer der 6 Kurzdarstellungen kann ein einführendes Referat (15 min, max. 2 Personen) gehalten werden.
- MA-Studierende, die Geschichte des Wissens schreiben, müssen auch den 5-seitigen Essay zu Michael Theunissen: "Die Gegenwart des Todes im Leben"
- Ihre Texte schicken Sie bitte an die eigens eingerichtete Email-Adresse:
  grundproblem-tod@ethz.ch
- Formalia (Minimalanforderungen):
  - Schriftbild: Zeilenabstand 1,5, Schriftgrösse 12, Seitenabstand 2,5cm, Schriftart: Arial, Times New Roman.
  - Vor- und Nachname, Matrikelnummer, Veranstaltungsname, Dozent, E-Mail-Adresse, Studiengang.
- organisatorische Rückfragen bitte an den Assistenten Raphael Salvi: raphael.salvi@phil.gess.ethz.ch

851-0125-57L  Values in Science
Number of participants limited to 25
3 credits  2S  K. Bachir

Abstract
851-0551-03L  Postal Knowledge and the History of Digital Societies
Particularly suitable for students of D-ARCH, D-BAUG, D-HEST, D-INFk, D-ITET, D-MAVT
3 credits  2S  D. F. Zetti

Abstract
In the second half of the 20th century, postal services have dramatically changed. Communication today is computer-based. The lecture offers problem oriented insights into this sociotechnical process of translation.

Objective
Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication.

Content

851-0157-66L  Who was Sigmund Freud?
3 credits  2S  M. Hagner

Abstract
This seminar is devoted to the introduction into the ideas and concepts of one of the most influential thinkers of the 20th century. We will read selected texts by Freud for getting an overview over his medical, psychological and cultural thinking.

Objective
30 years ago it would have been bizarre to ask the question: Who was Sigmund Freud? The influence of psychoanalysis on twentieth century thinking was taken for granted even by those ones who rejected Freud's ideas. In contrast, the question today would be: What are Freud's central theories? We will tackle this question in the seminar and reconstruct Freud's thinking from his early medical writings to his major works.

Prerequisites / notice
students need to read the texts in advance. The Vorlesung offers an introduction to the seminar and reconstruct Freud's thinking.

851-0127-28L  Death - The Secret Problem of Life
3 credits  2S  H. Wiedebach

Abstract
No detective novel without a corpse, no religion without knowledge about death and life, no large transplantation of an organ without certificate for the donor's death. Is a dead person always a corpse? - Death is part of life and yet stands simultaneously in opposition to it. We cling to life and nonetheless wish to have the option to commit suicide. Do we know what we really want in that case?

Objective
Discussion of 1) several conceptions of death in history, 2) determination of death in a medical sense (brain-death, etc.). 3) The search for a personal view about life and death. 4) The practice of a precise manner of speaking based on reflection.

Literature
Texte als Diskussionsgrundlage werden zu Beginn des Semesters genannt bzw. als PDF unter "Lernmaterialien" veröffentlicht. 4) The search for a personal view about life and death. 4) The practice of a precise manner of speaking based on reflection.

Prerequisites / notice
Leistungsnachweise der Studenten
- Es besteht Anwesenheitspflicht. Einmaliges Fehlen ist möglich mit Entschuldigung. Als Ersatz die Sitzung wird eine 4-seitige Darstellung des diskutierten Textes geliefert.
- Ab dem 2. Seminartermin erfolgt im Voraus pro Sitzung (d.h. insgesamt 6mal) eine 2-seitige Darstellung bzw. Stellungnahme zu einem vorgegebenen Text.
- Die 2-seitigen Darstellungen müssen bis Dienstag Abend in der Woche vor der nächsten Sitzung vorliegen, damit wir Zeit haben, sie zu lesen.
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- organisatorische Rückfragen bitte an den Assistenten Raphael Salvi: raphael.salvi@phil.gess.ethz.ch

851-0125-57L  Values in Science
Number of participants limited to 25
3 credits  2S  K. Bachir

Abstract
This course provides an introduction to philosophical issues surrounding quantum physics. In particular, we will examine different interpretations of quantum mechanics (such as the many-world interpretation) and the transition between the quantum and the classical physical realm (here phenomena such as decoherence will be highlighted).

Objective
By the end of the course students are able to describe and compare different interpretations of quantum mechanics. They are able to identify and examine issues concerning these different interpretations and issues concerning the transition between quantum and classical descriptions in physics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific contexts.
Abstract
Should science be free from moral, political or ideological influences? According to the so-called value-free ideal it should. Many scientists think of themselves as committed to truth and objectivity and nothing else. In this seminar, we will track the history of the value-free ideal and engage in a debate about the potential role of so-called non-epistemic values in science.

Objective
In the past decades, philosophers of science have begun to challenge the value-free ideal in science. With the help of recent literature from the philosophy of science, students will be introduced to the debate on values in science and the reasons for why the value-free ideal has come under attack. They will be familiarized with the distinction between epistemic (truth-conducive) values and so-called non-epistemic values. The course aims at enabling students to critically reflect the potential role of non-epistemic values in science.

Content
www.blogs.ethz.ch/valuesinscience/

Literature
www.blogs.ethz.ch/valuesinscience/

851-0157-67L
Creativity
W
3 credits
2S
M. Wulz, W. Wolff

Abstract
Being creative may appear to be the most important requirement of the present age: creative thinking, start-ups, project development all seem to promise an ongoing innovation of work and life. Instead of repeating that promise once again, this course asks for the historical conditions of discourses of creativity.

Objective
We will deal with historical and contemporary theories of inventive imagination, fantasy, and creativity. Looking at artistic, psychological, pedagogical, economic, and entrepreneurial discourses of creativity from the 18th to the 21st century we will discuss their specific contexts in order to uncover historical differences and changes. Is it indeed possible to identify conjunctions between the economization, scientification and normalization of creativity? Are there any alternatives to the reigning paradigm of creativity? And if so, what are these?

851-0157-68L
Publish or Perish, 1800-2016: On the History of Scientific Publishing
W
3 credits
2S
N. Guettler, M. Stadler

Abstract
From Plato, Aristotle and Cicero, philosophers have tried to find the core principle of wit (or the joke, as both meanings are contained in the German term "Witz"). From now on "Witz" is theoretically associated with the comical and laughter. Around 1900 there are approaches based on Semitic perceptions and Gender identity shaped scholars' choices of graphical and computational methods.

Objective
How did racial scientists determine racial affiliation? In the seminar we will examine the practical challenges and anthropological research from 1850 to the present. By scrutinizing the scientific toolbox of racial scientists, we will reveal how national affiliation, anti-Semitic perceptions and Gender identity shaped scholars' choices of graphical and computational methods.

Prerequisites / notice
Please note that the seminar will be held in English and most texts will be in English. However, a small portion of the reading material will be in German.

851-0157-69L
History of Astronomy
W
3 credits
2S
S. Mastorakou

Abstract
The course is designed to provide an overview of the astronomical developments from the ancient Greek world to the 16th century. We are going to use primary sources tackling historical, technical and philosophical questions. Special attention will be paid to the dramatic change in the way people understood the structure of the heavens and the nature of the physical world.

Objective
The course aims at providing a working knowledge of astronomy and cosmology from the ancient world to the 16th century. Upon completion the students will be able to describe how our knowledge of the heavens changed from Aristotle's system to the Copernican Revolution. In addition, they will also have acquired an appreciation of the debates about man's place in the cosmos and the philosophical principles underpinning cosmology.

851-0300-79L
Theories of Joke
W
3 credits
2S
A. Kilcher

Abstract
From Plato, Aristotle and Cicero, philosophers have tried to find the core principle of wit (or the joke, as both meanings are contained in the German term "Witz"). Even during the 20th century, the philosophy of life and psychoanalysis struggle with it. The seminar provides an overview of this history.

Objective
This seminar deals with the meaning and history of "Witz" (wit, joke) as a form of knowledge. It places "Witz" as a switch or transitional figure within the development of modern theories of knowledge in particular.

Content
Contrary to intuitive expectations, the German term "Witz" is not only an instance of the comical, but also a form of knowledge that plays on similarity and difference by juxtaposing the disparate. In this vein, especially during the 17th and 18th centuries, "Witz" becomes a central attribute of poetic and rhetorical types of expression (wit). Only during the 19th century "Witz" comes to denote a characteristic genre of the comical (joke). From now on "Witz" is theoretically associated with the comical and laughter.

851-0101-53L
Collections in Context: What Do Historians and Scientists Learn from Butterflies, Stones, and Bones?
W
3 credits
2S
B. Schär, M. Greeff

Abstract
Zurich holds huge scientific collections. They contain objects from around the world, some of them dating back to the 18th century. This interdisciplinary seminar combines perspectives from the history of science and from current scientific disciplines. What do these objects tell us about Zurich's place in the global history of science? What potentials do old collections hold for scientists today?

Objective
The aim of this seminar is threefold: Firstly, students will become familiarised with historiographical approaches to scientific collections. Among them are constructivist approaches that seek to understand scientific knowledge not primarily as a system of objective truths, but rather as an outcome of human 'constructions'. Other approaches deal with the problem of how scientific objects are related to systems of associated cultures of science.

Student participation is expected. Students will be expected to read theoretical texts and case studies during semester, participate in discussions with external experts (historians, curators, and scientists), and to write a summarizing essay at the end of the term.

Semester Report

Number: 862-0006-00L
Title: Semester Report
Type: O
ECTS: 3
Hours: 3A
Lecturers:

Data: 06.11.2018 12:57
Autumn Semester 2016
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Semester Paper

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Major Courses

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In the seminaries topics from the introductory courses are taught in more detail. Topics for essays are to be arranged with the teachers of the courses.

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<td>Ph.D. students and members of staff report on their research.</td>
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<td>Prerequisites</td>
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<td>851-0551-00L</td>
<td>Colloquium for Master and Ph.D. Students</td>
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<tr>
<td>862-0002-16L</td>
<td>Research Colloquium History of Knowledge (HS 2016)</td>
<td>W</td>
<td>2</td>
<td>1K+1A</td>
<td>A. Kilcher, K. M.</td>
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<td>Only for MAGPW students, D-GESS PHD and D-ARCH PHD students.</td>
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<td>Espahangizi, D. Gugerli,</td>
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<td>This colloquium is highly recommended for first and second</td>
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<td>M. Hagner, P. Sarasin,</td>
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<td>semester MAGPW students.</td>
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<td>J. Tanner, P. Ursprung,</td>
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<td>L. Wingert</td>
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Data: 06.11.2018 12:57
Autumn Semester 2016
Page 730 of 1571
Abstract
The colloquium of the ZGW focuses on present developments, debates and perspectives in the field of history of knowledge. On the second and fourth date there will be public events in the Cabaret Voltaire.

Objective
The colloquium deals with the general problems, questions and methods of the interdisciplinary research field "The History of Knowledge". Knowledge has become one of the existential conditions of modern societies and it increasingly determines their dynamics. Therefore, it is getting more and more relevant to develop a differentiated analysis of the epistemic, social and cultural constraints of the production, circulation and the decay of knowledge. In addition, the colloquium asks after the cultural and ethical resonances of knowledge not only within science but also in relation to art, literature, technology, everyday life, and so on.

Prerequisites / notice
Short notice about program changes are possible and will be communicated through the ZGW newsletter. Please register with www.zgw.ethz.ch/de/newsletter.html

Credit points can be gained by regular attending and by writing an essay. In addition to the five colloquia there will be a deepening seminar on offer (lecturer K. Esphahangizzi).

Free childcare available.

862-0078-02L Research Colloquium. Extra-European History and Global History (HS 2016)
For PhD students and postdoctoral. Masterstudents are welcome.

Abstract
The fortnightly colloquium provides a forum for PhD students and postdoctoral researchers to present and discuss their current work. Half of the slots are reserved for presentations by invited external scholars.

Objective
PhD students will have an opportunity to improve their presentation skills and obtain an important chance to receive feedback both from peers and more advanced scholars.

862-0004-03L Philosophical Colloquium (HS 2016)

Abstract
Ph.D. students, post docs, members of staff, and senior colleagues from other philosophy departments will report on their work in progress. Furthermore, promising new philosophical articles and parts of new philosophical books will be studied.

Objective
Ideas and arguments dealing with systematic problems especially in epistemology, ethics, political philosophy, and the philosophy of mind will be scrutinized and elaborated.

Master's Thesis
The work on the master-thesis is supervised by one of the teachers that are allowed to offer tutorials for it, named in the Leitfaden.

Number Title Type ECTS Hours Lecturers
862-0500-00L Master's Thesis O 30 credits 64D Supervisors
A student is only permitted to commence the Master thesis if
a. the Bachelor degree programme has been completed
b. any additional requirements for admission to the degree programme have been fulfilled
c. all credits have been acquired in the category research colloquium

Abstract
The Master's thesis gives a thorough historical, philological or philosophical analysis of a topic related to the experimental or formal sciences or to technology. It incorporates the relevant research literature on this topic as well as first attempts at original research.

Objective
The master thesis gives a thorough historical, philological or philosophical analysis of a topic related to the experimental or formal sciences or to technology. It incorporates the relevant research literature on this topic as well as first attempts at original research.

History and Philosophy of Knowledge Master - Key for Type

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<td>European Credit Transfer and Accumulation System</td>
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Special students and auditors need special permission from the lecturers.
Organic molecules: Isolation, separation and characterization of organic compounds. Classical structure theory: constitution, covalent

The course is designed to provide an understanding of the basic principles and concepts of general and inorganic chemistry.

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<th>Number</th>
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<tbody>
<tr>
<td>551-0105-00L</td>
<td>Fundamentals of Biology IA</td>
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<td>5</td>
<td>5G</td>
<td>M. Aebi, E. Hafen</td>
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Objective
Introduction to modern biology and to principal biological concepts.

Content
The course is divided into several chapters:
1. Basic principles of Evolution.
2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules
3. The cell: structure; membrane structure and function, cell cycle
4. Metabolism: Respiration; Photosynthesis; Fermentation
5. Inheritance: meiosis and sexual reproduction; Mendelian genetics, chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution

Lecture notes
None.

Literature
The text-book "Biology" (Campbell, Reece) (10th edition) is the basis of the course.

The structure of the course is largely identical with that of the text-book.

Prerequisites / notice
Certain sections of the text-book must be studied by self-instruction.

529-1001-01L General Chemistry (for Biology/Pharmacy/HST) O 4 credits 4V W. Uhlig

Abstract
The lecture deals with a number of basic chemistry concepts. These include amongst others chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

Objective
The course is designed to provide an understanding of the basic principles and concepts of general and inorganic chemistry.

Content
The lecture deals with a number of basic chemistry concepts. These include amongst others chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

Literature

Prerequisites / notice
As a supplement, a selection of textbooks is proposed during the course.

529-1011-00L Organic Chemistry I (for students of Biology, Pharmaceutical Sci., and Health Sci. & Tech.) O 4 credits 4G C. Thilgen

Abstract
Fundamentals of Organic Chemistry: molecular structure. Bonding and functional groups; nomenclature; resonance and aromaticity; stereochemistry; conformation; bond strength; organic acids and bases; basic reaction thermodynamics and kinetics; reactive intermediates: carbanions, carbenium ions and radicals.

Objective
Understanding the basic concepts and definitions of organic chemistry. Knowledge of the functional groups and classes of compounds that are important in biological systems. Foundations for the understanding of the relationship between structure and reactivity.

Content

Lecture notes
Printed lecture notes are available. Exercises, answer keys and other handouts can be downloaded from the Moodle course "Organic Chemistry I" of the current semester (https://moodle-app2.let.ethz.ch).

Literature
Lecture notes are available.

Prerequisites / notice
The course consists of plenary lectures (2 h per week) and problem-solving lessons (2 h per week, groups of ca. 25 people). In addition, online exercises are available in the e-learning environment Moodle (Course OC I).

401-0291-00L Mathematics I O 6 credits 4V+2U E. W. Farkas

Abstract
Mathematics I/II is an introduction to one- and multidimensional calculus and linear algebra emphasizing on applications.

Objective
Students understand mathematics as a language for modeling and as a tool for solving practical problems in natural sciences. Students can analyze models, describe solutions qualitatively or calculate them explicitly if need be. They can solve examples as well as their practical applications manually and using computer algebra systems.

Content
Einführung in die Differential- und Integralrechnung von Funktionen einer Variablen und Anwendungen:

Literature
Siehe Lernmaterialien > Literatur
L. Papula, Mathematik für Ingenieure und Naturwissenschaftler, 11. Auflage, Vieweg und Teubner
Th. Wihler, Mathematik für Naturwissenschaften, 2 Bände: Einführung in die Analysis, Einführung in die Lineare Algebra; Haupt-Verlag Bern, UTB.
Ch. Blatter, Lineare Algebra; VDF
H. H. Storrer: Einführung in die mathematische Behandlung der Naturwissenschaften I; Birkhäuser.
Prerequisites / notice

Der Zugang zu den Übungsseiten erfolgt online.
Vorlesungsverzeichnis > Lernmaterialien > Material zur Vorlesung

252-0852-00L Foundations of Computer Science O 4 credits 2V+2U L. E. Fässler, H.J. Böckenhauer, M. Dahinden, D. Komm, H. Lehner

Abstract
Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects.

The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.

Objective
The students learn to
- understand the role of computer science in science,
- to control computer and automate processes of problem solving by programming,
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

Content
1. The role of computer science in science
2. Introduction to Programming with Python
3. Modeling and simulations
4. Introduction to Matrices with Matlab
5. Visualizing multidimensional data
6. Data management with lists and tables
7. Data management with a relational database
8. Universal methods for algorithm design

Lecture notes
All materials for the lecture are available at www.gdi.ethz.ch

Prerequisites / notice
This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

376-0003-00L Introduction to Health Sciences and Technology I O 4 credits 2V+2U R. Müller

Abstract
Overview on various aspects of health and disease (health models, classification of diseases, prevention and rehabilitation, therapy, epidemiology); introduction to technical aspects (diagnostics, measurement technique); fundamentals of scientific working (ethics, literature search, study design, data collection, data analysis and data presentation).

Objective
Students should know the terms, models and classification systems used in health and disease; in addition, they should understand the methods of scientific working.

Content
- Health: biomedical model and classification of diseases, salutogenesis and ICF, prevention and rehabilitation, therapy, epidemiology.
- Technology: diagnostics, measurement technology, automatic control engineering.
- Science: ethics, literature search, study design, tests, data analysis, data presentation.

First Year Laboratory Courses

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Abstract
Delivery of practical insight into research methods relevant to the field by means of demonstrations and small projects in the areas of Human Movement Science and Sport, Medical Technology, Molecular Health Sciences, and Neurosciences.

Objective
Students can experience research methods that may arise in the field of Health Sciences and Technology.

Content
- Human Movement Science and Sport: movement analysis, biomechanical measurement techniques
- Medical Technology: prostheses
- Molecular Health Sciences: metabolism, behaviour
- Neurosciences: neurological measurement techniques, neurorehabilitation
- Clinical Research

Second Year Compulsory Subjects

Examination Blocks

Examination Block 1

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<tr>
<td>551-0103-00L</td>
<td>Fundamentals of Biology II: Cell Biology</td>
<td>O</td>
<td>5</td>
<td>5V</td>
<td>E. Hafen, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner</td>
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Abstract
The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Objective
The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

Content
The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the netzh (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.

Literature

Prerequisites / notice
Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.
### Abstract

This course will provide insight into various aspects of medical device design such as patient needs assessment, product specification, research and technical design, validation, regulatory affairs and clinical evaluation.

### Objective

The goal of this lecture series is to enable the students to (i) identify the principal functional requirements for a medical device, (ii) understand the mechanical properties of natural tissues and synthetic biomaterials, (iii) to apply this information and a basic knowledge of mechanics in the calculation of implant performance, (iv) to develop a plan for the pre-clinical evaluation and regulation of a new device.

### Content

1. Introduction to Medical Technology
2. Design Process
3. Mechanics
4. Mechanics of Materials
5. Tissue Mechanics
6. Prostheses: Biomechanics and Design
7. Prostheses: Biomaterials, Surfaces and Wear
8. Allografts: Heart Valves
9. Preclinical Evaluation
10. Regulatory Affairs (MepV, FDA, CE)
11. Intellectual Property
12. Group Work and Presentation


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### Examination Block 2

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<td>401-0293-00L</td>
<td>Mathematics III</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>A. Caspar, N. Hungerbühler</td>
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**Abstract**

Vertiefung der mehrdimensionalen Analysis mit Schwerpunkt in der Anwendung der partiellen Differentialgleichungen, Vertiefung der Linearen Algebra und Einführung in die Systemanalyse und Modellbildung.

**Objective**

Die Studierenden

- verstehen Mathematik als Sprache zur Modellbildung und als Werkzeug zur Lösung angewandter Probleme in den Naturwissenschaften.
- können anspruchsvolle Modelle analysieren, Lösungen qualitativ beschreiben oder allenfalls explizit berechnen: diskret/kontinuierlich in Zeit, Ebene und Raum.
- können Beispiele und konkrete arithmetische und geometrische Situationen der Anwendungen mit Methoden der höheren Mathematik interpretieren und bearbeiten.

**Content**

#### Modellbildung ####

- Einführung und Beispiele
- Mehrdimensionale Modelle
- Pocken-Modell
- SIR-Modell

#### Lineare Modelle ####

- Vektorräume
- Diagonalisierbarkeit
- Normalformen
- Exponential einer Matrix
- Lösungsraum eines Linearen DGL-Systems

#### Fourier-Reihen ####

- Euklidische Vektorräume
- Orthogonale Projektion
- Anwendungen

#### Nichtlineare Modelle ####

- Stationäre Lösungen, Qualitative Aussagen
- Mehrdimensionale Modelle: Räuber-Beute, Lotka-Volterra

#### Partielle Differentialgleichungen ####

- Einführung, Repetition, Beispiele
- Fourier-Methoden: Wärmeleitung, Laplace, Wellengleichung, Filter, Computertomographie

#### Laplace-Transformation ####

- Definition und Notation
- Rechenregeln
- Anwendungseinspiel

**Lecture notes**

II (nächstes Semester)

**Literature**

Siehe Lernmaterial > Literatur I (nächstes Semester)

**Prerequisites / notice**

- Vorlesungen Mathematik II/III

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### Statistics II

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<td>401-0643-13L</td>
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<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>M. Kalisch</td>
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**Abstract**

Vertiefung von Statistikmethoden. Nach dem detaillierten Fundament aus Statistik I liegt nun der Fokus auf konzeptueller Breite und konkreter Problemlösungsfähigkeit mit der Statistiksoftware R.

### Examination Block 3

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<tbody>
<tr>
<td>376-0151-00L</td>
<td>Anatomy and Physiology I</td>
<td>O</td>
<td>5 credits</td>
<td>4V</td>
<td>M. Ristow, K. De Bock, L. Slomianka, C. Spengler, N. Wenderoth, D. P. Wolfer</td>
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**Abstract**

Basic knowledge of the anatomy and physiology of tissues, of the embryonal and postnatal development, of the basic terminology of pathology, the neuro-muscular system, the cardiovascular system and the respiratory systems.

**Objective**

Basic knowledge of human anatomy and physiology and basics of clinical pathophysiology.

**Content**

Short overview of human anatomy, physiology and general pathology.

**Anatomy and Physiology I** (fall term):

- Basics of cytology, histology, embryology, general pathology; nervous system, muscles, cardiovascular system, respiratory system
- Digestive system, kidney and urinary tract, endocrine system, skin, thermoregulation, sensory organs, male and female reproductive system, pregnancy and child birth.

**Literature**

- "Wolfer, Rhyner, Sebele und Müntener; "Anatomie und Physiologie"; http://www.dpwolfer.ch"

**Prerequisites / notice**

Voraussetzungen; 1. Jahr, naturwissenschaftlicher Teil

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0043-00L</td>
<td>Physics I</td>
<td>O</td>
<td>4 credits</td>
<td>3V+1U</td>
<td>T. Esslinger</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

**Objective**

The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.

**Content**

Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids) Periodic Motion and Waves (periodic motion, mechanical waves, acoustics).

**Lecture notes**

The lecture follows the book "Physics" by Paul A. Tipler.

**Literature**

- Schiebler TH, Korf H-W: Anatomie (10. vollständig überarbeitete Auflage)
- Steinkoppf / Springer, Heidelberg 2007
- Martini FH, Timmons MJ, Tallitsch RB. Human Anatomy

**Prerequisites / notice**

Paul A. Tipler and Gene P. Mosca, Physics (for Scientists and Engineers), W. H. Freeman and Company

### Examination Block 4

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0007-00L</td>
<td>Advanced Anatomy and Physiology I</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>K. De Bock, N. Wenderoth, D. P. Wolfer</td>
</tr>
</tbody>
</table>

**Abstract**

Advanced knowledge of anatomy and physiology, molecular mechanisms and cellular function of tissues as well as pathophysiological aspects of different organ systems.

**Objective**

Advanced knowledge of human anatomy and physiology and of molecular and pathophysiological aspects.

**Content**

- Closer look to the nervous system.
- Advanced Anatomy and Physiology II (spring term):
- Introduction to Molecular Biology; Closer look to muscles, cardiovascular system, and respiratory system as well as immunology.

### Third Year Focus Courses

#### Focus Courses: Human Movement Science and Sport

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0203-00L</td>
<td>Movement and Sport Biomechanics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>B. Taylor, R. List, S. Lorenzetti</td>
</tr>
</tbody>
</table>

**Abstract**

Learning to view the human body as a (bio-) mechanical system. Making the connections between everyday movements and sports activity with injury, discomfort, prevention and rehabilitation.

**Objective**

Students are able to describe the human body as a mechanical system. They analyse and describe human movement according to the laws of mechanics.

**Content**

Movement- and sports biomechanics deals with the attributes of the human body and their link to mechanics. The course includes topics such as functional anatomy, biomechanics of daily activities (gait, running, etc.) and looks at movement in sport from a mechanical point of view. Furthermore, simple reflections on the loading analysis of joints in various situations are discussed. Additionally, questions covering the statics and dynamics of rigid bodies, and inverse dynamics, relevant to biomechanics are investigated.

<table>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
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</thead>
<tbody>
<tr>
<td>376-0207-00L</td>
<td>Exercise Physiology</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>C. Spengler</td>
</tr>
</tbody>
</table>

**Abstract**

This course provides an overview over molecular and systemic aspects of neuromuscular, cardiovascular and respiratory adaptations to acute and chronic exercise as well as the interactions of the different systems influencing factors, e.g. genetics, gender, age, altitude/depth, heat/cold, with respect to performance and health.

**Objective**

The aim of this course is to understand molecular and systemic aspects of neuromuscular, cardiovascular and respiratory adaptations to acute and chronic exercise as well as the interaction of the different systems regarding health-relevant aspects and performance in healthy people and persons with selected diseases. Furthermore, students will understand the influence of genetics, gender, age, altitude/depth, heat and cold on the named factors.
The course covers the development of the nervous system (NS) with a focus on neurogenesis and migration, axon growth, synapse formation, mol. & cell. mechanisms, and diseases of the developing NS.

Handouts provided during the classes and references therin.

### Focus Courses: Medical Technology

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-0021-00L</td>
<td>Introduction to Biomedical Engineering I</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Christen, R. Müller, J. G. Snedeker, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

### Focus Courses: Neurosciences

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-1305-00L</td>
<td>Development of the Nervous System</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>E. Stoeckli, further lecturers</td>
</tr>
</tbody>
</table>
Objective
The aim is to give a deepened insight into the normal development, of the nervous system based on molecular, cellular and biochemical approaches.

Content
The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

Lecture notes
Must be downloaded from OLAT: https://www.olat.uzh.ch/olat/dmz/

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

Prerequisites / notice
Auxiliary tools:
None. Bring something to write and your student ID

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<tr>
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</thead>
<tbody>
<tr>
<td>376-1305-01L</td>
<td>Structure, Plasticity and Repair of the Nervous System</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Schwab, L. Filli, K. A. Martin, further lecturers</td>
</tr>
</tbody>
</table>

Abstract
The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

Objective
The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content
The main focus is on the plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes
ETH students: Lecture notes will be provided on Moodle: https://moodle-app2.let.ethz.ch/course/view.php?id=694
UZH students: Lecture notes will be provided on OLAT: https://www.olat.uzh.ch/olat/dmz/

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-0309-00L</td>
<td>Concepts in Modern Genetics</td>
<td>W</td>
<td>6 credits</td>
<td>4V</td>
<td>Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, C. Voynet</td>
</tr>
</tbody>
</table>

Abstract
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective
This course focuses on the concepts of classical and modern genetics and genomics.

Content
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes
Scripts and additional material will be provided during the semester.

Prerequisites / notice
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel.

Electives

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
</tbody>
</table>

Abstract
Theory and application of thermodynamics and energy conversion in biological systems with focus on the cellular level.

Objective
Theory and application of energy conversion at the cellular level. Understanding of the basic features governing solutes transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biophysics. Heat and mass transport processes in the cell, generation of forces, work and relation to biomedical technologies.

Content
Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

Literature
Material in the form of hand-outs will be distributed.

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>151-0575-01L</td>
<td>Signals and Systems</td>
<td>W</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>R. D’Andrea</td>
</tr>
</tbody>
</table>

Abstract
Signals arise in most engineering applications. They contain information about the behavior of physical systems. Systems respond to signals and produce other signals. In this course, we explore how signals can be represented and manipulated, and their effects on systems. We further explore how we can discover basic system properties by exciting a system with various types of signals.

Objective
Master the basics of signals and systems. Apply this knowledge to problems in the homework assignments and programming exercise.

Content

Lecture notes
Lecture notes available on course website.

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<tr>
<th>Number</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
</tbody>
</table>

Abstract
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

Objective
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Content
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

Lecture notes
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

<table>
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<tr>
<th>Number</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0917-00L</td>
<td>Mass Transfer</td>
<td>W</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>R. Büchel, S. E. Pratsinis</td>
</tr>
</tbody>
</table>
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore, the application of these principles to important engineering problems is demonstrated.

**Objective**

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore, the application of these principles to important engineering problems is demonstrated.

**Content**

Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogeneous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogeneous reaction. Applications.

**Literature**


**Prerequisites / notice**

Two tests are offered for practicing the course material. Participation is mandatory.

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Type</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>277-0045-00L</td>
<td>Signals and Systems I</td>
<td>W</td>
<td>4</td>
<td>2V+2U</td>
<td>H. Bölcskei</td>
</tr>
<tr>
<td>327-0103-00L</td>
<td>Introduction to Materials Science</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>M. Niederberger, N. Spencer, P. Uggowitzer</td>
</tr>
<tr>
<td>376-0130-00L</td>
<td>Laboratory Course in Exercise Physiology</td>
<td>W</td>
<td>3</td>
<td>4P</td>
<td>C. Spengler</td>
</tr>
<tr>
<td>376-1033-00L</td>
<td>History of Sports</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Gisler</td>
</tr>
<tr>
<td>376-1107-00L</td>
<td>Sport Pedagogy</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>D. Seiler Hubler</td>
</tr>
</tbody>
</table>
### 376-1117-00L Sport Psychology

**Objective**
To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.

**Content**
Inhalte der Vorlesung sind:
- Einführung in die Sportpädagogik und die pädagogische Psychologie des Sportunterrichts
- Bedeutung des Sports im Jugendalter
- Zeitgemäßer Sportunterricht
- Sport und Leistung
- Heterogenität im Sportunterricht
- Sport und Gesundheit
- Geschlechterfragen im Sport
- Soziale und moralische Entwicklung im Sportunterricht

**Lecture notes**
Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

**Literature**

**Abstract**
This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.

**Objective**
Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students’ expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

**Content**
Main Topics
- Introduction to sport psychology
- Cognitions in sports: mental rehearsal and mental training
- Emotions and stress
- Motivation: goal-setting in sports
- Career and career transition in elite sport
- Coach-Athlete-Interaction
- Psychological aspects of sport-injury rehabilitation
- Group dynamics in sport

**Lecture notes**
Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

**Literature**

### 376-1127-00L Sociology of Sport

**Objective**
The lectures set out to:
- provide an introduction to the central theories and models of (sport) sociology
- show how far sport reflects society and how it changes and becomes more differentiated in the process
- take current examples from newspapers, magazines and television to highlight the sociological view of sport.

**Content**
Sport and social change: developments and trends
- The economy and the media: dependencies, consequences, scandals
- Social inequalities and distinctions: gender differences and group behavior
- Conflicts and politics: sports organizations, doping, violence

**Lecture notes**
Selected materials for the lecture are available under www.LSSFB.ch --> Lehre

**Literature**

A detailed program with additional references will be delivered at the beginning of the lecture.

### 376-1155-00L The Musculoskeletal System and Work

**Objective**
Consolidated findings of movement sciences concerning deterioration, overload and regeneration of the musculoskeletal system are an important basis for an ergonomic working environment. The following topics are covered: Muscle fatigue during the 8-hour day, use of the computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.

**Content**
- Goal of the course is the activation of physiological and patho-physiological insights for the understanding of loads of the musculoskeletal
- System during work. Prevention and rehabilitation of work related musculoskeletal disease will be discussed with the help of a bio-
- Computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.

**Lecture notes**
Skript und Folien auf NETZ als PDF-Datei zur Verfügung

**Prerequisites / notice**

### 376-1581-00L Cancer: Fundamentals, Origin and Therapy

**Objective**

**Content**
Students are able to describe selected chemicals, biological and molecular processes that occur in cells spontaneously or after physical or chemical exposure and resulting in a tumor. They are able to list important cancer-inducing agents and explain the respective mechanism of action. They have knowledge of significant risk factors for cancer diseases. They are confronted with the basics of toxicology and they can explain the principle of the most common therapeutic strategies.
The lecture deals with problems of tumor epidemiology (causes, mortality, incidence). Cancer is delineated as a multi-step process. Classes of chemical compounds that induce cancer are discussed as well as the reactive metabolites that may be built from. Covalent binding to DNA is discussed and different types of mutations resulting thereof. A selection of proto-oncogenes and tumor suppressor genes is presented. Their function will be discussed as well as the changes which are found in these genes in tumor cells, starting from single nucleotide exchanges up to large deletions.

The reason for genetic predisposition to cancer will be discussed as well as cancer relevant aspects of cell cycle regulation. Phenomenons like angiogenesis and metastasis are presented as well as the mechanisms that protect the genome from mutagenic damage. Further subjects address old and new strategies of cancer treatment. Personalised cancer treatment.

Lecture notes
Handouts with reproductions of all presented transparencies will be distributed.

Literature

additional informations are given during the lecture

Prerequisites / notice
The lecture requires an active participation of the students. All students will participate in individual or group work focussing on specific subject of the lecture. Students will have ample time for preparation during lecture time.

376-1665-00L
Training and Coaching I
W 3 credits 2G O. Buholzer

Abstract
The combining of training and coaching as in the example of sport analysis, which has an effect on youth training and athlete development

Objective
- To develop basics for a differential analyses of sports (model)
- To develop a profile of requirements for specific sports
- To develop competencies of training with youth and talents
- To develop the basics of talent training in theory and practice
- To observe athletes in case studies, make judgments and conclusion

Content
Das Modell der Sportartenanalyse
Die Relevanz der einzelnen Leistungs faktoren
Das Modell der Wettkampfanalyse
Folgerungen für das Training und Coaching in der Sportart
Folgerungen für das Nachwuchstraining
Folgerungen für die Athletenauswahl, Athletenbeobachtung und -betreuung
Das Nachwuchs- und Talenttraining (Sichtung, Selektion, Förderung)
Projekte aus der Praxis (Talent- und Nachwuchstraining)
Praxisinput zum Thema Koordination, motorische Grundbedürfnisse, Kraft und Gesundheit
Praxisbeispiele erarbeiten und planen
Konkrete Athletenbeobachtung

Lecture notes
Die Skript- (Lektionsunterlagen) werden im Rahmen des Semesters abgeben und auf Homepage veröffentlicht.

Literature

Leistungsdiagnostische Verfahren, Stiehler(Konzag/Döbler)
Training fundiert erklärt, Handbuch der Trainingslehre, Ingold Verlag 2006
Das sportliche Talent, W. Joch, Meyer&Meyer Verlag, 2002
Das neue Konditionstraining, Grosser/Statruchka/Zimmermann, blv 2002

Prerequisites / notice
Für die Kreditvergabe sind die vorgeschriebenen Semesterarbeiten und die Präsenz zwingend. Die Benotung erfolgt durch eine schriftliche Arbeit.

Planung
Die Planungsunterlagen werden zu Semesterbeginn abgegeben, sind provisorisch und können vom Dozenten geändert werden. Die Praxislektionen werden jeweils am Mittwoch von 13.00 - 15.00 abgehalten. Die Termine werden in Absprache festgelegt.

Die Semesterarbeit ist 4 Wochen nach Semesterende abzugeben.


376-1716-00L
Basics of Exercise Therapy
W 2 credits 2V K. Marschall

Number of participants limited to 30.
Possible from the 5th semester on.
Requirement:"Introduction of Exercise Therapy" passed.

Abstract
Basics of Exercise Therapy:
A: diagnostic, anamnese, diagnostic of movement and function, assessments in exercise therapy, diagnostic of experience and behavior in relation to movement
B: biological-medical basics, pathophysiological Basics (internal, orthopedic and psychological deseases).
C: didactic knowledge, Reha-didactic

Objective
Students learn the assessments to plan an exercise-therapy-treatment.
They are able to use them. They're able to integrate biological and medical basics.
They are able to prepare a therapy-session

Content
Grundlagen der Diagnostik, Anamnese,
Bewegungsdagnostik, Funktionsdiagnostik
Sport- und Bewegungstherapeutische Testverfahren
Motorische Basisdiagnostik
Diagnostik bewegungsbezogenen Erlebens und Verhaltens
Biomechanik (v.a. Gelenke), Pathophysiologische Grundlagen, Modelle der Methodik und Didaktik, Lektionsplanung

Lecture notes
wird vor Semesterbeginn elektronisch zur Verfügung gestellt

Literature
- Schüle / Huber: Grundlagen der Sporttherapie, Deutscher Ärzteverlag, Köln 2012
- Deimel et al.: Neue aktive Wege in Prävention und Rehabilitation, Deutscher Ärzteverlag, Köln 2007

Prerequisites / notice
lecture "Introduction in Exercise Therapie" ist prerequisite

90% of the lections students must be present.
Practical Basics in Sports and Exercise Therapy

**376-1717-00L**

**W** 2 credits 2V  B. Spörri Kälin, B. Keller

*Number of participants limited to 30.*

**Abstract**

Possible from the 5th semester on.

**Objective**

Impart knowledge of practical basics of Sports and Exercise Therapy

**Content**

The members are able to transform the knowledge from the previous courses in practical situations of Sports and Exercise Therapy. They learn basic aspects to design therapy lessons.

**Lecture notes**

The courses "Introduction in Sports and Exercice Therapy" has been completed successfully.

Prerequisites / notice

**376-1722-00L**

**Spinal Cord Injury and Exercise**

**Prerequisites:** Anatomy and Physiology

**W** 2 credits 2V  C. Perret

**Abstract**

Intensive discussion concerning complications of a spinal cord injury and their consequences on trainability and exercise performance of persons sitting in a wheelchair. Overview on the clinical application of exercise testing as well as on the implementation of sport scientific findings to optimise performance of spinal cord injured subjects in rehabilitation and elite sports.

**Objective**

Knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport.

**Content**

The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; trainability/exercise physiology and spinal cord injury; history and organisation of wheelchair sports; elite sport and spinal cord injury

**Literature**

General literature:

- G.A. Zäch, H. G. Koch
  - Paraplegie - ganzheitliche Rehabilitation
  - Karger-Verlag, 2006
  - ISBN 3-8055-7900-2

- V. Goosney-Tolrey
  - Wheelchair sport: A complete guide for athletes, coaches and teachers
  - Human Kinetics, 2010

- Y.C. Vanlandewijck, W.R. Thompson
  - The Paralympic Athlete

- Liz Broad
  - Sports Nutrition for Paralympic Athletes
  - CRC Press 2014

**Prerequisites / notice**

Voraussetzung: Vorlesung Anatomie/Physiologie besucht!

**529-0731-00L**

**Nucleic Acids and Carbohydrates**

**W** 6 credits 3G  D. Hilvert, P. A. Kast, S. J. Sturla, H. Wennenemers

**Abstract**

Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Objective**

Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Content**

Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Lecture notes**

Mainly based on recent original literature, a detailed list will be distributed during the first lecture

**529-1023-00L**

**Physical Chemistry I (for Biology and Pharmacy)**

**W** 3 credits 2V+1U  R. Riek, H. P. Lüthi

**Abstract**


**Objective**

Understanding the fundamental thermodynamical properties of chemical and biological systems.

**Content**


**Lecture notes**

in process, will be distributed at the beginning of the first lecture


**Prerequisites / notice**

Prerequisite: mathematics I-II, functions of multiple variables, partial derivatives.

**535-0230-00L**

**Medicinal Chemistry I**

**W** 2 credits 2V  J. Hall

**Abstract**

The lectures give an overview of selected drugs and the molecular mechanisms underlying their therapeutic effects in disease. The historical and modern-day methods by which these drugs were discovered and developed are described. Structure-function relationships and the biophysical rules underlying ligand-target interactions will be discussed and illustrated with examples.

**Objective**

Basic understanding of therapeutic agents with respect to molecular, pharmacological and pharmaceutical properties.

**Content**

Molecular mechanisms of action of drugs. Structure function and biophysical basis of ligand-target interactions

**Lecture notes**

Will be provided in parts before each individual lecture.
The aim of the lecture course is to provide a solid overview of gene technology, with a special focus on drug development. Topics: Antibody phage technology, DNA-encoded chemistry, protein modification technology, genome sequencing, transcriptomics, proteomics, functional genomics, principle of drug discovery. The course is suited for advanced undergraduate and early graduate students in pharmaceutical sciences or related fields.

Requirements: Knowledge of physical and organic chemistry, biochemistry and biology. Attendance of Medicinal Chemistry II in the spring semester.
Content
1. Antibody phage technology
   - The antibody molecule
   - V genes, CDRs, basics of antibody engineering
   - Principles of phage display
   - Phagemid and phage vectors
   - Antibody libraries
   - Phage display selection methodologies
   - Other phage libraries (peptides, globular proteins, enzymes)
   - Alternative screening/selection methodologies
   - DNA-encoded chemical libraries

2. Proteins: chemical modification and detection of biomolecular interactions
   - Homo- and hetero-dimerization of proteins
   - Chemical modifications of proteins
   - Antibody-drug conjugates
   - Radioactive labeling of proteins
   - Kinetic association and dissociation constants
   - Affinity constant: definition and its experimental measurement

3. Genomics: Applications to Human Biology
   - Protein cloning and expression
   - DNA sequencing
   - Some foundations of genetic analysis
   - Knock-out technologies
   - Transcriptomics
   - Proteomics
   - Recombinant vaccines

4: Pharmaceuticals: Focus on Discovery
   - Ligand Discovery
   - Half-life extension
   - Cancer therapy
   - Gene therapy

535-0830-00L Pharmaceutical Immunology W 2 credits 2G D. Neri, C. Halin
Abstract Get Students familiar with basic Immunological concepts of pharmaceutical relevance.
Objective Get Students familiar with basic Immunological concepts of pharmaceutical relevance.
Content Chapters 1 - 11 of the Janeway’s ImmunoBiology, by Kenneth Murphy (9th Edition; Garland).
Literature Janeway’s ImmunoBiology, by Kenneth Murphy (9th Edition).
Lecture notes Skript “Gene Technology” by Prof. Dario Neri and slides of the lecture

551-0309-00L Concepts in Modern Genetics W 6 credits 4V Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voinnet
Abstract Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.
Objective This course focuses on the concepts of classical and modern genetics and genomics.
Content The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.
Lecture notes Scripts and additional material will be provided during the semester.
Prerequisites / notice This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel.

551-0317-00L Immunology I W 3 credits 2V A. Oxenius, M. Kopf
Abstract Introduction into structural and functional aspects of the immune system.
Objective Basic knowledge of the mechanisms and the regulation of an immune response.
Content - Introduction and historical background
   - Innate and adaptive immunity, Cells and organs of the immune system
   - B cells and antibodies
   - Generation of diversity
   - Antigen presentation and Major Histoincompatibility (MHC) antigens
   - Thymus and T cell selection
   - Autoimmunity
   - Cytotoxic T cells and NK cells
   - Th1 and Th2 cells, regulatory T cells
   - Allergies
   - Hypersensitivities
   - Vaccines, immune-therapeutic interventions

Lecture notes Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"
Prerequisites / notice Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

551-0319-00L Cellular Biochemistry (Part I) W 3 credits 2V U. Kutay, R. I. Enchev, B. Kommann, M. Peter, I. Zemp, further lecturers
Abstract Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

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<th>Course Code</th>
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<th>Credits</th>
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<tbody>
<tr>
<td>551-1003-00L</td>
<td>Methods of Biological Analysis</td>
<td>W 3 credits</td>
<td>G 3</td>
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<tr>
<td>Lecture notes</td>
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<tr>
<td>Literature</td>
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<td>Prerequisites / notice</td>
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<th>Course Code</th>
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<th>Credits</th>
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<tbody>
<tr>
<td>551-1295-00L</td>
<td>Introduction to Bioinformatics: Concepts and Applications</td>
<td>W 6 credits</td>
<td>G 4</td>
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<tr>
<td>Abstract</td>
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<td>Objective</td>
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In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.
Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

Fundamentals of Biology II: Biochemistry and Molecular Biology

**Abstract**
The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.

**Objective**
Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycans, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.

**Literature**

**Prerequisites / notice**
Some of the lectures are given in the English language.
Content
The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.

Lecture notes
There is no script. Powerpoint presentations will be made available.

Literature
Elmadfa I & Leitzmann C: Ernährung des Menschen
UTB Ulmer, Stuttgart, 4. überarb. Ausgabe 2004

Garrow JS and James WPT: Human Nutrition and Dietetics
Churchill Livingstone, Edinburgh, 11th rev. ed. 2005

752-6301-00L Selected Topics in Physiology Related to Nutrition W 3 credits 2V W. Langhans
Abstract
Gives the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand.

Objective
Some basic knowledge in physiology is recommended for this course, which revisits important physiological topics, emphasizing their relation to nutrition. The aim is to give the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand. For students with a background in medicine, pharmacy or biology, the course is useful as a review of previously acquired knowledge. Major topics are basic neuroanatomy and neurophysiology; general endocrinology; the physiology of taste and smell; nutrient digestion and absorption; intermediary metabolism and energy homeostasis; and some aspects of cardiovascular physiology and water balance.

Lecture notes
Handouts for each lecture will be made available every week: http://www.fpb.ethz.ch/teaching/handouts.html

752-6403-00L Nutrition and Performance W 2 credits 2V S. Mettler, M. B. Zimmermann
Abstract
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

Objective
To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

Content
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Literature
Lecture slides and required handouts will be available on the ETH website.

Prerequisites / notice
Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

Language: English
It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

853-0033-00L Leadership I W 3 credits 2V F. Kernic
Abstract
The lectures "Leadership I" (WS) and "Leadership II" (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. "Leadership I" covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

Objective
The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.

Prerequisites / notice
The 1-hour written exam will take place during the last lecture in the semester.

GESS Science in Perspective
Science in Perspective
Recommended Science in Perspective (Type B) for D-HEST.

see Science in Perspective: Type A: Enhancement of Reflection Capability

Language Courses
see Science in Perspective: Language Courses ETH/UZH

Sport Practical
Assessments

Sport Practical Basic Education

Sport Practical Advanced Education

Health Sciences and Technology Bachelor - Key for Type
O Compulsory E- Recommended, not eligible for credits
W+ Eligible for credits and recommended Z Courses outside the curriculum
W Eligible for credits Dr Suitable for doctorate
### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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**ECTS**
European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH).

In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH).

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
<tr>
<td>851-0240-03L</td>
<td>Introduction to Test Theory and Test Construction in Educational Contexts (University of Zürich)</td>
<td>W</td>
<td>4 credits</td>
<td>2S</td>
<td>University lecturers</td>
</tr>
<tr>
<td>851-0240-15L</td>
<td>Colloquium on the Science of Learning and Instruction</td>
<td>W</td>
<td>1 credit</td>
<td>1K</td>
<td>E. Stern, P. Greutmann, further lecturers</td>
</tr>
<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4 W DZ)</td>
<td>W</td>
<td>2 credits</td>
<td>3S</td>
<td>A. Deilmayr, P. Greutmann, U. Markwalder</td>
</tr>
</tbody>
</table>

Lecturers

Human Learning (EW1)
This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

Abstract

The course provides an overview of methods of research in learning and instruction. Students gain an understanding of the differences in learning ability and their causes: Intelligence theories, sex differences in learning; Learning as a transfer of knowledge; Learning through instruction and explanations; The role of emotion and motivation in learning; Individual differences in learning ability and their reasons: Intelligence theories, sex differences in learning.

Objective

The specific learning outcomes are:
- describe the scientific fundamentals of test theory and test structure;
- evaluate examples of scientifically-developed tests in their application context;
- if necessary, critically question the performance assessment that they employ in practice and professionalise it still further;
- describe the scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.

Content

The concrete contents of the seminars result from the preferences of the participants and the conclusions drawn from them.

The following topics are covered:
- Testenwicklung;
- Gütekriterien von Tests;
- Aufgabenkonstruktion;
- Datenauswertung;
- Rasch-Modell;
- Internationale Vergleichstests;
- Zulassungsstests

Lecture notes

- Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören auch die Handouts der verschiedenen, studentischen Vorträge.
- Die konkreten Inhalte des Seminars ergeben sich aufgrund der Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:
- Testenwicklung;
- Gütekriterien von Tests;
- Aufgabenkonstruktion;
- Datenauswertung;
- Rasch-Modell;
- Internationale Vergleichstests;
- Zulassungsstests

Literature


Prerequisites / notice

This course is only apt for students who intend to enrol in the programs "Lehrdipлом" or "Didaktisches Zertifikat". It is about learning in childhood and adolescence.
This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of 3G.

**Title**
- Get to know cognitively activating instructions in MINT subjects

**ECTS**
- Students know how to prepare, conduct and reflect a single lesson based on educational requirements.

**1S 4 credits**

### Cognitively Activating Instructions in MINT Subjects

R. Schumacher  
P. Edelsbrunner

**Type**
- In this course students learn the principles and techniques of teaching singular lessons, based on scientific knowledge about learning. The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5-10 students) will be discussed.

**Objective**
- Understanding research methods used in the empirical educational sciences
- Understanding findings relevant for education
- Getting information about recent literature on learning and instruction
- Understanding pedagogically relevant findings from the empirical educational sciences

**Abstract**

- Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.
Objective
Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Further Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>376-8011-00L</td>
<td>Mentored Work Subject Didactics Health Sciences and Technology</td>
<td></td>
<td>2</td>
<td>4A</td>
<td>S. Maurer</td>
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<td><em>Only for Health Sciences and Technology TC students.</em></td>
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</table>

Abstract
The mentored paper is designed to bring together the findings from the FD1 and the FD2. By using various teaching techniques and methods a semester plan, which is based on various curricula will be elaborated for a given topic.

Objective
1. The students have planned a curriculum for a semester course.
2. Students reflect on formative and summative ways such a teaching unit to examine and implement parts of it.
3. The students have implemented parts of the semester curriculum.
4. The students deal with the question to what extend teaching techniques, teaching methods but also sequences of self-study must be involved in the planning.

Health Sciences and Technology TC - Key for Type

| O | Compulsory                  | E- | Recommended, not eligible for credits |
| W+| Eligible for credits and recommended | Z  | Courses outside the curriculum       |
| W | Eligible for credits        | Dr | Suitable for doctorate               |

Key for Hours

| V | lecture                   | P  | practical/laboratory course         |
| G | lecture with exercise     | A  | independent project                 |
| U | exercise                  | D  | diploma thesis                      |
| S | seminar                   | R  | revision course / private study     |
| K | colloquium                |     |                                       |

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Health Sciences and Technology Master
► Major in Human Movement Science and Sport

►► Compulsory Courses

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<tbody>
<tr>
<td>376-0390-00L</td>
<td>Translational Science for Health and Medicine</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>J. Goldhahn, C. Wolfrum</td>
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Abstract:
Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

Objective:
After completing this course, students will be able to understand: Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication).

Content:
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- Ethical considerations including ethics application
- Prox and cons of different types of research
- Coordination of complex approaches incl. timing and resources
- Outcome variables
- Improving the translational process

Challenges of communication:
- How independent is translational science?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

►► Electives

►►► Electives Courses I

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>376-0221-00L</td>
<td>Methods and Concepts in Human Systems Neuroscience and Motor Control</td>
<td>W</td>
<td>3</td>
<td>3P</td>
<td>N. Wenderoth</td>
</tr>
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</table>

Abstract:
This course provides hands-on experience with measurement and analysis methods relevant for Humans Systems Neuroscience and Motor control (nerve/brain stimulation, EMG, EEG, psycho-physical paradigms etc). Students read scientific material, set up experiments, perform measurements in the lab, analyse data, apply statistics and write short reports or essays.

Objective:
This course will prepare students for experimental work as it is typically done during the master thesis. The goal is to gain hands-on experience with measurement and analysis methods relevant for Humans Systems Neuroscience and Motor control (for example peripheral nerve stimulation, electrical and magnetic brain stimulation, EMG, EEG, psycho-physical paradigms etc). Students will learn how to perform small scientific projects in this area. Students will work individually or in small groups and solve scientific problems which require them to perform measurements in human participants, extract relevant readouts from the data, apply appropriate statistics and interpret the results. They will also be required to write small essays and reports and they will get feedback on their writing throughout the course.

Prerequisites / notice:
Students are required to have successfully completed the course “Neural control of movement and motor learning” and to have basic knowledge of applied statistics. Self-study material about applied statistics will be available at the beginning of the course and statistical knowledge will be tested (central element) in the second course week. Passing this test is a requirement for continuing the course. Students will have to solve scientific problems, requiring them to independently study scientific material, apply statistics and report their results in the form of written reports and essays. Assessments will be made on the basis of the completed theoretical and practical work that will be performed either in small groups or individually.

376-0223-00L | Advanced Topics in Exercise Physiology                     | W    | 3    | 2S    | C. Spengler, F. Gabe Beltrami, J. M. Kroepfl |

Abstract:
In this course, students read, present and discuss seminal publications in the area of exercise physiology. The focus lies on critical analysis of scientific content, conceptual as well as ethical aspects of publications. Students are trained in the most common scientific presentation techniques such as oral and poster presentations.

Objective:
Students gain further knowledge and a deeper understanding of concepts in exercise physiology. Emphasis is put on critical analysis and discussion of scientific publications as well as on improving scientific presentation skills.

Literature
Material will be provided in moodle.

Prerequisites / notice:
Successful completion of the Exercise Physiology Course.

376-0225-00L | Physical Activities and Health                            | W    | 3    | 2V    | E. de Bruin             |

Abstract:
This course introduces/explores the complex relationship between physical activity, sedentary behavior and health. It will discuss the evolution of current physical activity recommendations. It will examine the current evidence base that has informed physical activity recommendations and that identified physical activity as a key modifiable lifestyle behavior contributing to disease and mortality.

Objective:
On completion of this course students will be able to demonstrate:
1. knowledge of and critical awareness of the role of physical activity and sedentary behavior in the maintenance of health and the aetiology, prevention and treatment of disease.
2. thorough knowledge and critical awareness of current recommendations for physical activity, and current prevalence and trends of physical activity and associated diseases
3. awareness of current national and international physical activity policies and how these impact on global challenges

Content:
- Introduction to Physical Activity for Health, including sedentary behavior
- Physical activity epidemiology; concepts principles and approaches
- Physical activity and all cause morbidity and mortality
- Physical activity and chronic disease; Coronary heart disease, diabetes, bone health, cancer and obesity
- Physical activity and brain health
- Physical activity and sedentary behavior recommendations
- Population prevalence of physical activity and sedentary behavior
- Physical activity policies
- Physical activity assessment

Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)
Core texts for this course are:


Selective journal articles from relevant journals such as Journal of Physical Activity and Health and Journal of Aging and Physical Activity

**Prerequisites / notice**

From the BSc-course the following book is recommended: ‘Essentials of strength training and conditioning’ T. Baechle, R. Earle (3rd Edition)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1651-00L</td>
<td>Clinical and Movement Biomechanics</td>
<td>W</td>
<td>4 credits</td>
<td>S. Lorenzetti, R. List, N. Singh</td>
<td></td>
</tr>
</tbody>
</table>

**Abstract**

Measurement and modeling of the human movement during daily activities and in a clinical environment.

**Objective**

The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.

**Content**

This course includes study design, measurement techniques, clinical testing, accessing movement data and anysis as well as modeling with regards to human movement.

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<tr>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-6101-00L</td>
<td>Dietary Etiologies of Chronic Disease</td>
<td>W</td>
<td>3 credits</td>
<td>M. B. Zimmermann</td>
<td></td>
</tr>
</tbody>
</table>

**Abstract**

To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Objective**

To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

**Content**

The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Lecture notes**

There is no script. Powerpoint presentations will be made available on-line to students.

**Literature**

To be provided by the individual lecturers, at their discretion.

**Prerequisites / notice**

No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

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### Elective Courses II

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4 credits</td>
<td>P. Koumoutsakos</td>
<td></td>
</tr>
</tbody>
</table>

**Abstract**

Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

**Objective**

The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

**Content**

Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

**Lecture notes**

Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

**Literature**

1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

**Prerequisites / notice**

Fundamentals of Probability, Fundamentals of Computational Modeling

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6 credits</td>
<td>S. Kozerke, K. P. Prüssmann, M. Rudin</td>
<td></td>
</tr>
</tbody>
</table>

**Abstract**

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

**Objective**

To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

**Content**

- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

**Lecture notes**

Lecture notes and handouts

**Literature**

Weed A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011 Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

**Prerequisites / notice**

<table>
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<tr>
<th>Number</th>
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<th>ECTS</th>
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</thead>
<tbody>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4 credits</td>
<td>J. Várórs, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
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</table>

**Abstract**

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

**Objective**

This course is an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

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Introduction to Biomedical Engineering
by Enderle, Banchard, and Bronzino
AND
https://www1.ethz.ch/lbb/Education/BME

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Lecture</th>
<th>Credits</th>
<th>ECTS</th>
<th>Main Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W</td>
<td>6</td>
<td>3+1U</td>
<td>L. Van Gool, O. Gökse, E. Konukoglu</td>
</tr>
<tr>
<td>327-2125-00L</td>
<td>Microscopy Training SEM I - Introduction to SEM</td>
<td>W</td>
<td>1</td>
<td>3P</td>
<td>S. Rodighiero, A. G. Bittermann, K. Kunze, J. Reuteler</td>
</tr>
<tr>
<td>327-2126-00L</td>
<td>Microscopy Training TEM I - Introduction to TEM</td>
<td>W</td>
<td>1</td>
<td>3P</td>
<td>S. Rodighiero</td>
</tr>
</tbody>
</table>

Abstract

Objective
- Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
- The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
- Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites / notice
- Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

Prerequisites:
- No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

Number of participants limited to 6.

Abstract
- The introductory course on Scanning Electron Microscopy (SEM) emphasizes hands-on learning. Using 2 SEM instruments, students have the opportunity to study their own samples, or standard test samples, as well as solving exercises provided by ScopeM scientists.

Objective
- Set-up, align and operate a SEM successfully and safely.
- Accomplish imaging tasks successfully and optimize microscope performances.
- Master the operation of a low-vacuum and field-emission SEM and EDX instrument.
- Perform sample preparation with corresponding techniques and equipment for imaging and analysis
- Acquire techniques in obtaining secondary electron and backscatter electron micrographs
- Perform EDX qualitative and semi-quantitative analysis

Content
- During the course, students learn through lectures, demonstrations, and hands-on sessions how to setup and operate SEM instruments, including low-vacuum and low-voltage applications. This course gives basic skills for students new to SEM. At the end of the course, students with no prior experience are able to align a SEM, to obtain secondary electron (SE) and backscatter electron (BSE) micrographs and to perform energy dispersive X-ray spectroscopy (EDX) qualitative and semi-quantitative analysis. The procedures to better utilize SEM to solve practical problems and to optimize SEM analysis for a wide range of materials will be emphasized.

- Discussion of students' sample/interest
- Introduction and discussion on Electron Microscopy and instrumentation
- Lectures on electron sources, electron lenses and probe formation
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM
- Brief description and demonstration of the SEM microscope
- Practice on beam/specimen interaction, image formation, image contrast (and image processing)
- Student participation on sample preparation techniques
- Scanning Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities
- Lecture and demonstrations on X-ray micro-analysis (theory and detection), qualitative and semi-quantitative EDX and point analysis, linescans and spectral mapping
- Practice on real-world samples and report results

Literature
- Detailed course manual

Prerequisites / notice
- No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.
C. Spengler

Overview of TEM theory, instrumentation, operation and applications.
- Alignment and operation of a TEM, as well as acquisition and interpretation of images, diffraction patterns, accomplishing basic tasks successfully.
- Knowledge of electron imaging modes (including Scanning Transmission Electron Microscopy), magnification calibration, and image acquisition using CCD cameras.
- To set up the TEM to acquire diffraction patterns, perform camera length calibration, as well as measure and interpret diffraction patterns.
- Overview of techniques for specimen preparation.

Content
Using two Transmission Electron Microscopes the students learn how to align a TEM, select parameters for acquisition of images in bright field (BF) and dark field (DF), perform scanning transmission electron microscopy (STEM) imaging, phase contrast imaging, and acquire electron diffraction patterns. The participants will also learn basic and advanced use of digital cameras and digital imaging methods.
- Introduction and discussion on Electron Microscopy and instrumentation.
- Lectures on electron sources, electron lenses and probe formation.
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM.
- Brief description and demonstration of the TEM microscope.
- Practice on beam/specimen interaction, image formation, image contrast (and image processing).
- Demonstration of Transmission Electron Microscopes and imaging modes (Phase contrast, BF, DF, STEM).
- Student participation on sample preparation techniques.
- Transmission Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.
- TEM alignment, calibration, correction to improve image contrast and quality.
- Electron diffraction.
- Practice on real-world samples and report results.

Literature

Prerequisites / notice
No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

363-0301-00L Work Design and Organizational Change

W 3 credits 2G G. Grote

Abstract
Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.

Objective
- Know effects of work design on competition, motivation, and well-being
- Understand links between design of individual jobs and work processes
- Know basic processes involved in systematic organizational change
- Understand the interaction between organization and technology and its impact on organizational change
- Understand relevance of work design for company performance and strategy
- Know and apply methods for analyzing and designing work

Content
- Work design: From Adam Smith to job crafting
- Effects of work design on performance and well-being
- Approaches to analyzing and designing work
- Modes of organizational change and change methods
- Balancing stability and flexibility in organizations as design criterion
- The organization-technology interaction and its impact on work design and organizational change
- Example Flexible working arrangements
- Strategic choices for work design

363-0790-00L Technology Entrepreneurship

W 2 credits 2V U. Claesson, B. Clarysse

Abstract
Technology entrepreneurs are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding. This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

Objective
This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

Content
See course website: http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html

Lecture notes
Lecture slides and case material

376-0130-00L Laboratory Course in Exercise Physiology

W 3 credits 4P C. Spengler

Number of participants limited to 48.

Abstract
Conduct physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that deepen the understanding of physiological processes in response to physical exertion.

Objective
Gain hands-on experience in exercise physiology and consolidate knowledge on physiological adaptations to different types and degrees of physical activity and climatic influences. Learn fundamental assessment techniques of the muscular system, the cardio-respiratory system and of whole-body performance, learn scientifically correct data analysis and interpretation of results. Insight into today's Sports Medicine.

Content
- Laboratory course:
  - Various exercise tests assessing human performance and assessments of physiological responses to activity (examples are VO2max-test, Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test), dynamometry, mechanography, body composition etc.). Insight into measurements in Sports Medicine.

Lecture notes
Tutorial on Laboratory Experiments in Exercise Physiology (Editor: Exercise Physiology Lab)

Literature
Schmidt/Lang/Heckmann: Physiologie des Menschen, Springer-Verlag, Heidelberg

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 754 of 1571
We'll prepare you to produce your MSc thesis. You'll learn how to structure your thesis, write scientific English, and manage your writing.

Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of

Recommended textbooks:

W. McArdle, Frank I. Katch, Victor L. Katch

W.L. Kenney, J.H. Wilmore, D.L. Costill

S. Milligan
B. Taylor
Movement and Sport Biomechanics

This course provides an overview over molecular and systemic aspects of neuromuscular, cardiovascular and respiratory adaptations to acute and chronic exercise as well as the interactions of the different systems influencing factors, e.g. genetics, gender, age, altitude/depth, heat/cold, with respect to performance and health.

The aim of this course is to understand molecular and systemic aspects of neuromuscular, cardiovascular and respiratory adaptations to acute and chronic exercise as well as the interaction of the different systems regarding health-relevant aspects and performance in healthy people and persons with selected diseases. Furthermore, students will understand the influence of genetics, gender, age, altitude/depth, heat and cold on the named factors.

Literature

Online material is provided during the course.

Recommended textbooks:

William D. McArdle, Frank I. Katch, Victor L. Katch

W.L. Kenney, J.H. Wilmore, D.L. Costill

S. Milligan

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Attention: Registration is only possible from 12.9. (from 11.30h) - 15.9.2016

We'll prepare you to produce your MSc thesis. You'll learn how to structure your thesis, write scientific English, and manage your writing efficiently. You'll receive detailed feedback on work in progress.

By the end of the course students are able to plan, draft, and edit academic English papers and theses; structure and write clear texts in a style which is acceptable to their academic discourse community; manage the writing process efficiently; select formal vocabulary and use it in a generally accurate and correct manner; choose and use generally suitable grammatical structures, punctuation, and orthographic conventions, assess their own effectiveness as writers of academic English, and identify areas in which further development is needed.

The course covers the writing context; the writing process; structuring sentences, paragraphs, longer sections (such as introduction, methods, results, and discussion), and whole texts; presenting and integrating non-textual elements such as graphs and tables; and editing and correcting drafts and proofs. Each lesson comprises a mixture of elements, including specialist input, individual tasks, pairwork, and groupwork. Active participation is expected.

Comprehension for development and changes of sports from the ancient world to the presence. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.


Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.
These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.

Objective
- The lectures set out to:
  - present the different dimensions, functions and interrelationships of present-day sport
  - provide an introduction to the central theories and models of (sport) sociology
  - show how sport reflects society and how it changes and becomes more differentiated in the process
  - take current examples from newspapers, magazines and television to highlight the sociological view of sport.

Content
- Sport and social change: developments and trends
- The economy and the media: dependencies, consequences, scandals
- Social inequalities and distinctions: gender differences and group behavior
- Conflicts and politics: sports organizations, doping, violence

Lecture notes
Selected materials for the lecture are available under www.LSSFB.ch --> Lehre

Literature

A detailed program with additional references will be delivered at the beginning of the lecture.

Sport Psychology
This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.

Objective
- Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students' expertise is furthered by presenting and providing the selected intervention forms that are provided to insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognized. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

Content
- Main Topics
  - Introduction to sport psychology
  - Cognitions in sports: mental rehearsal and mental training
  - Emotions and stress
  - Motivation: goal-setting in sports
  - Career and career transition in elite sport
  - Coach-Athlete-Interaction
  - Psychological aspects of sport-injury rehabilitation
  - Group dynamics in sport

Lecture notes
Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

Literature


Human Factors I
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective
- The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry, Digital Human Models
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature
- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBiS as electronic version and for free to ETH students
- Further textbooks are introduced in the lecture
- Brouchures, checklists, key articles etc. are uploaded in ILIAS

Applications of Cybernetics in Ergonomics
Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involving the performance in multi-model interactions, quantification in gestalt principles in product development; or the information processing matter.

Objective
- To learn and practice cybernetics principles in interface designs and product development.

Content
- Fitt's law applied in manipulation tasks
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection
- Accommodationvergence crosslink function
- Cross-link models in neurobiology- the ocular motor control system
- Human performance in optimization of production lines
Abstract
Rehabilitation Engng is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

Content
Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces
Literature

Introductory Books:


Selected Journal Articles and Web Links:


Prerequisites / notice

Target Group:
Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

376-1714-00L Biocompatible Materials W 4 credits 3G K. Maniura, J. Möller, M. Zenobi-Wong

Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes
Handouts can be accessed online.
This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented.

The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport.

Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

Students will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

Prerequisite: Anatomy and Physiology

Handouts will be made available.

Handouts provided during the classes and references therin.

A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

Furthermore possibilities to prevent injuries are discussed. Thereby the lecture focuses on sports injuries.

Handouts will be made available.

Handouts will be made available.

A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

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Based on practical examples out of sport, everyday movement and therapy, students use and compare different methods of movement analysis.

Students are able to assess human movement using different methods of movement analysis.

During the course students get acquainted with different methods of movement analysis such as: functional, morphological, clinical, mechanical, and others.

Based on practical examples, these methods are used and compared. The examples range from sport, everyday movement and therapy, such as hockey, gymnastics, acrobatics, badminton, gait / running and strength training. In the first phase of the class, the different approaches are applied. In the second phase, small teams are working on individual projects. These will be discussed and presented in plenum.

Class material will be distributed using the moodle platform.

Script and original publications will be supplied during the course.

Table of contents:

- Nutrition and Performance
- Epidemiology and Prevention
- Public Health Concepts
- Nutrition and Performance

### Nutrition and Performance

**Number:** 752-6403-00L  
**Title:** Nutrition and Performance  
**ECTS:** 2  
**Hours:** 2  
**Lecturers:** S. Mettler, M. B. Zimmermann

**Abstract**  
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

**Objective**  
To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

**Content**  
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

**Lecture notes**  
Lecture slides and required handouts will be available on the ETH website.

**Literature**  
Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

**Prerequisites / notice**  
General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

### Major in Human Health, Nutrition and Environment

#### Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-1153-00L</td>
<td>Systems Biology of Metabolism</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>U. Sauer, N. Zamboni, M. Zampieri</td>
</tr>
</tbody>
</table>

Abstract  
Based on practical examples out of sport, everyday movement and therapy, students use and compare different methods of movement analysis.

Objective  
Students are able to assess human movement using different methods of movement analysis.

Content  
During the course students get acquainted with different methods of movement analysis such as: functional, morphological, clinical, mechanical, and others.

Based on practical examples, these methods are used and compared. The examples range from sport, everyday movement and therapy, such as hockey, gymnastics, acrobatics, badminton, gait / running and strength training. In the first phase of the class, the different approaches are applied. In the second phase, small teams are working on individual projects. These will be discussed and presented in plenum.

Lecture notes  
Class material will be distributed using the moodle platform.

Prerequisites / notice  
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

| 752-6105-00L | Epidemiology and Prevention | W | 3 | 2V | M. Puhan, R. Heusser |

Abstract  
The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.

Objective  
The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware of how epidemiological facts are used in prevention, practice and politics.

Content  
The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples from nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

Lecture notes  
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

| 752-6151-00L | Public Health Concepts | W | 3 | 2V | R. Heusser |

Abstract  
The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

Objective  
At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

Content  
Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

Lecture notes  
Handouts are provided to students in the classroom.

Language of the course is English.

| 752-6403-00L | Nutrition and Performance | W | 2 | 2V | S. Mettler, M. B. Zimmermann |

Abstract  
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

Objective  
To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

Content  
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Lecture notes  
Lecture slides and required handouts will be available on the ETH website.

Literature  
Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

Prerequisites / notice  
General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.
Translational Science for Health and Medicine

**Abstract**
Translational science is a cross-disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

**Objectives**
- Acquisition of knowledge in the field of the review paper
- Assessment of original literature as well as synthesis and analysis of the findings
- Practising academic writing in English
- Giving an oral presentation with discussion on the topic of the review paper

**Content**
- What is translational science and what is it not?
- How to identify need?
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
- How to measure success?
- Outcome variables
- Improving the translational process
- Challenges of communication?
- How independent is translational science?
- Academic boundary conditions vs. industrial influences
- Positive and negative examples will be illustrated by distinguished guest speakers.

**Literature**
Guidelines will be handed out in the beginning.

**Literature**
- Literature will be identified based on the topic chosen.

**Electives**

**Electives Courses I**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0629-00L</td>
<td>Applied Biostatistics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Müller</td>
</tr>
<tr>
<td>Abstract</td>
<td>Principles and main methods in biostatistics with emphasis on practical aspects. Experimental and observational studies. Regression and analysis of variance. Introduction into survival analysis.</td>
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<tr>
<td>Objective</td>
<td>Getting an overview of the problems and statistical methods used in health sciences. Practise in using the software R to analyze data and interpreting the suits.</td>
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<tr>
<td>Lecture notes</td>
<td>see teaching document repository</td>
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</table>

**Prerequisites**
The statistical package R will be used in the exercises. If you are unfamiliar with R, I highly recommend the online R course etutoR.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6105-00L</td>
<td>Epidemiology and Prevention</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. Puhan, R. Heusser</td>
</tr>
<tr>
<td>Abstract</td>
<td>Information for UZH students: Enrolment to this course unit only possible at ETH. No enrolment to module CS16_101 at UZH. Please mind the ETH enrolment deadlines for UZH students: <a href="https://www.ethz.ch/en/studies/non-degree-courses/special-students-special-students-university-of-zurich.html">https://www.ethz.ch/en/studies/non-degree-courses/special-students-special-students-university-of-zurich.html</a></td>
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<td>Abstract</td>
<td>The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.</td>
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<td>The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.</td>
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<tr>
<td>Content</td>
<td>The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.</td>
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<tbody>
<tr>
<td>752-6151-00L</td>
<td>Public Health Concepts</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Heusser</td>
</tr>
<tr>
<td>Abstract</td>
<td>The module &quot;public health concepts&quot; offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.</td>
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</table>
At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

Handouts are provided to students in the classroom.

Language of the course is English.

Objectives of the course:

1. **Basic Knowledge**: A detailed understanding of computational biology and its applications in infectious disease biology.
2. **Practical Skills**: Ability to analyze and interpret genetic sequencing data using computational tools.
3. **Critical Thinking**: Understanding of evolutionary principles and their application in infectious disease biology.


### Elective Courses II

#### Module: Infectious Diseases

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0223-00L</td>
<td>Immunology III</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>M. Kopf, M. Bachmann, J. Kisielow, A. Lanza, S. R. Leibundgut, A. Oxenius, R. Spörri</td>
</tr>
</tbody>
</table>

**Abstract**

This course provides a detailed understanding of:
- Development of T and B cells
- The dynamics of an immune response during acute and chronic infection
- Mechanisms of immunopathology
- Modern vaccination strategies

Key experimental results will be shown to help understanding how immunological text book knowledge has evolved.

**Objective**

Obtain a detailed understanding of:
- The development, activation, and differentiation of different types of T cells and their effector mechanisms during immune responses,
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter,
- Events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells.
- Optimization of B cell responses by intelligent design of new vaccines

**Content**

- Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
- NK T cells and responses to lipid antigens
- Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
- Overview of cytokines and their effector function
- Co-stimulation (signals 1-3)
- Dendritic cells
- Evolution of the "Danger" concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunctions in acute and chronic viral infections

**Literature**

Documents of the lectures are available for download at: https://moodle-app2.let.ethz.ch/course/view.php?id=2581&notifiyeditingon=1

**Prerequisites / notice**

Immunology I and II recommended but not compulsory

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>636-0017-00L</td>
<td>Computational Biology</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>T. Stadler, C. Magnus</td>
</tr>
</tbody>
</table>

**Abstract**

The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.

**Objective**

Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:
- Stochastic models in molecular evolution
- Phylogenetic & phylodynamic inference
- Maximum likelihood and Bayesian statistics

Attendees will apply these concepts to a number of applications yielding biological insight into:
- Epidemiology
- Pathogen evolution
- Macroevolution of species

**Content**

The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

**Lecture notes**

Slides of the lecture will be available online.
https://www.bsse.ethz.ch/cevo/education/cb-materials.html

**Literature**

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

**Prerequisites / notice**

Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

<table>
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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0263-01L</td>
<td>Seminar in Evolutionary Ecology of Infectious Diseases</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>D. Croll, S. Bonhoeffer, R. R. Regös</td>
</tr>
</tbody>
</table>

**Abstract**

Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.
This course provides an overview about the following topics: Factors influencing consumer’s food choice, food and health, attitudes towards
W
Copy of the power point slides from lectures will be provided.
Students will learn to (i) identify evolutionary explanations for the origins and characteristics of infectious diseases in a range of organisms
Students will read the primary literature on each topic, and in places we will use the following books:
Functional Microorganisms in Foods
S. de Wouters, L. Meile,
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant
2V
Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional
- Industrial Biotechnology of Flavor and Taste Development
- Legal and Protection Issues Related Functional Foods
- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Safety of Food Starter Cultures and Probiotics
Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will
- Safety of Food Starter Cultures and Probiotics

Objective
This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

Content
A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

Lecture notes
Publications and class notes can be downloaded from a web page announced during the lecture.

Literature
Papers will be assigned and downloaded from a web page announced during the lecture.

701-1703-00L Evolutionary Medicine for Infectious Diseases W 3 credits 2G A. Hall

Abstract
This course explores infectious disease from both the host and pathogen perspective. Through short lectures, reading and active discussion, students will identify areas where evolutionary thinking can improve our understanding of infectious diseases and, ultimately, our ability to treat them effectively.

Objective
Students will learn to (i) identify evolutionary explanations for the origins and characteristics of infectious diseases in a range of organisms and (ii) evaluate ways of integrating evolutionary thinking into improved strategies for treating infections of humans and animals. This will incorporate principles that apply across any host-pathogen interaction, as well as host-specific mechanistic information, with particular emphasis on bacteria and viruses.

Content
We will cover several topics where evolutionary thinking is relevant to understanding or treating infectious diseases. This includes: (i) determinants of host range and virulence, (ii) dynamics of host-parasite coevolution, (iii) pathogen adaptation to evade or suppress immune responses, (iv) antimicrobial resistance, (v) evolution-proof medicine. For each topic there will be a short (< 30 minutes) introductory lecture, before students independently research the primary literature and develop a half page of discussion points and questions, followed by interactive discussion in class.

Literature
Students will read the primary literature on each topic, and in places we will use the following books:
- Schmid Hempel 2011 Evolutionary Parasitology
- Stearns & Medzhitov 2016 Evolutionary Medicine

Prerequisites / notice
A basic understanding of evolutionary biology, microbiology or parasitology will be advantageous but is not essential.

752-4009-00L Molecular Biology of Foodborne Pathogens W 3 credits 2V M. Loessner, M. Schuppler

Abstract
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

Content
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

Lecture notes
Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

Literature
Recommendations will be given in the first lecture

Prerequisites / notice
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break !

Module: Nutrition and Health

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Siegrist, C. Hartmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.</td>
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<tr>
<td>Objective</td>
<td>The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues</td>
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</table>

752-5103-00L Functional Microorganisms in Foods W 3 credits 2G C. Lacroix, T. de Wouters, L. Meile, C. Schwab

Abstract
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

Objective
To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilizing high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

Content
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Probiotics

Lecture notes
Copy of the power point slides from lectures will be provided.

Literature
A list of references will be given at the beginning of the course for the different topics presented during this course.

752-6101-00L Dietary Etiologies of Chronic Disease W 3 credits 2V M. B. Zimmermann

Data: 06.11.2018 12:57
Autumn Semester 2016
Page 763 of 1571
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural

To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Objective

To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic
disease, as well as the progression of complications of the chronic diseases.

Content

The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes,
gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Lecture notes

There is no script. PowerPoint presentations will be made available on-line to students.

Literature

To be provided by the individual lecturers, at their discretion.

Prerequisites / notice

No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

<table>
<thead>
<tr>
<th>Module: Environment and Health</th>
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<tr>
<td><strong>Number</strong></td>
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<tr>
<td>701-1341-00L</td>
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</tbody>
</table>

Abstract

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

Objective

The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Content

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Lecture notes

Handouts will be distributed

Literature

Will be mentioned in handouts

<table>
<thead>
<tr>
<th>Major in Medical Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compulsory Courses</td>
</tr>
<tr>
<td><strong>Number</strong></td>
</tr>
<tr>
<td>376-0300-00L</td>
</tr>
</tbody>
</table>

Abstract

Translational science is a cross-disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.
After completing this course, students will be able to understand:
Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)

What is translational science and what is it not?
How to identify need?
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
How to measure success?
- Outcome variables
- Improving the translational process
Challenges of communication?
- How independent is translational science?
- Academic boundary conditions vs. industrial influences
Positive and negative examples will be illustrated by distinguished guest speakers.

Electives

Elective Courses I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0021-00L</td>
<td>Introduction to Biomedical Engineering I</td>
<td>W</td>
<td>4</td>
<td>3</td>
<td>P. Christen, R. Müller, J. G. Snedeker, M. Zenobi-Wong</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<tr>
<td></td>
<td>Understanding of physical and technical principles in biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering. Mathematical description and problem solving. Knowledge of biomedical engineering applications in research and clinical practice.</td>
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<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>Tissue and Cellular Biomechanics, Molecular Biomechanics and Biopolymers, Computational Biomechanics, Biomaterials, Tissue Engineering, Radiation and Radiographic Imaging, Diagnostic Ultrasound Imaging, Magnetic Resonance Imaging, Biomedical Optics and Lasers.</td>
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<tr>
<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Stored on ILIAS</td>
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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1714-00L</td>
<td>Biocompatible Materials</td>
<td>W</td>
<td>4</td>
<td>3</td>
<td>K. Maniura, J. Möller, M. Zenobi-Wong</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Introduction to molecules for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.</td>
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<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>The class consists of three parts:</td>
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<tr>
<td></td>
<td>1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.</td>
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<tr>
<td></td>
<td>2. The concept of biocompatibility.</td>
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<td></td>
<td>3. Introduction into methodology used in biomaterials research and application.</td>
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<tr>
<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed. In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.</td>
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<tr>
<td></td>
<td>Handouts can be accessed online.</td>
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</tbody>
</table>

Elective Courses II

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>D. Poulidakos, A. Ferrari</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<tr>
<td></td>
<td>Theory and application of thermodynamics and energy conversion in biological systems with focus on the cellular level.</td>
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<tr>
<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>Theory and application of energy conversion at the cellular level. Understanding of the basic features governing solutes transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biophysics. Heat and mass transport processes in the cell, generation of forces, work and relation to biomedical technologies.</td>
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</tr>
<tr>
<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.</td>
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<tr>
<td></td>
<td>Material in the form of hand-outs will be distributed.</td>
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<tr>
<td>Literature</td>
<td>Lectures</td>
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<tr>
<td></td>
<td>Note on this textbook, references therein.</td>
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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4</td>
<td>3</td>
<td>B. Nelson</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<tr>
<td></td>
<td>Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.</td>
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<tr>
<td></td>
<td>Note on this textbook, references therein.</td>
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</tbody>
</table>
Objective

The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Content

Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

Lecture notes

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

Prerequisites / notice

The lecture will be taught in English.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lecture Type</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>S. Kozerke, K. P. Prüssmann, M. Rudin</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.</td>
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<tr>
<td>Objective</td>
<td>To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.</td>
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</tbody>
</table>

| Lecture notes | Lecture notes and handouts |
| Literature    | Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011 |
| Prerequisites / notice | Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming |

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lecture Type</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0391-00L</td>
<td>Medical Image Analysis</td>
<td>W</td>
<td>3</td>
<td>P. C. Cattin, M. A. Reyes Aguirre</td>
</tr>
<tr>
<td>Abstract</td>
<td>It is the objective of this lecture to introduce the basic concepts used in Medical Image Analysis. In particular the lecture focuses on shape representation schemes, segmentation techniques, and the various image registration methods commonly used in Medical Image Analysis applications.</td>
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<tr>
<td>Objective</td>
<td>This lecture aims to give an overview of the basic concepts of Medical Image Analysis and its application areas. Basic knowledge of computer vision would be helpful.</td>
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<tr>
<td>Prerequisites / notice</td>
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</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lecture Type</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0393-10L</td>
<td>Bioelectronics and Biosensors</td>
<td>W</td>
<td>6</td>
<td>J. Vörös, M. F. Yanik, T. Zambelli</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course introduces the concepts of bioelectricity and biosensing. The sources and use of electrical fields and currents in the context of biological systems and problems are discussed. The fundamental challenges of measuring biological signals are introduced. The most important biosensing techniques and their physical concepts are introduced in a quantitative fashion.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>During this course the students will: - learn the basic concepts in biosensing and bioelectronics - be able to solve typical problems in biosensing and bioelectronics - learn about the remaining challenges in this field</td>
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</tbody>
</table>

Autumn Semester 2016
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience

L1. Bioelectronics history, its applications and overview of the field
   - Volta and Galvani dispute
   - BMI, pacemaker, cochlear implant, retinal implant, limb replacement devices
   - Fundamentals of biosensing
   - Glucometer and ELISA

L2. Fundamentals of quantum and classical noise in measuring biological signals

L3. Biomeasurement techniques with photons

L4. Acoustics sensors
   - Differential equation for quartz crystal resonance
   - Acoustic sensors and their applications

L5. Engineering principles of optical probes for measuring and manipulating molecular and cellular processes

L6. Optical biosensors
   - Differential equation for optical waveguides
   - Optical sensors and their applications
   - Plasmonic sensing

L7. Basic notions of molecular adsorption and electron transfer
   - Quantum mechanics: Schrödinger equation energy levels from H atom to crystals, energy bands
   - Electron transfer: Marcus theory, Gerischer theory

L8. Potentiometric sensors
   - Fundamentals of the electrochemical cell at equilibrium (Nernst equation)
   - Principles of operation of ion-selective electrodes

L9. Amperometric sensors and bioelectric potentials
   - Fundamentals of the electrochemical cell with an applied overpotential to generate a faraday current
   - Principles of operation of amperometric sensors
   - Ion flow through a membrane (Fick equation, Nernst equation, Donnan equilibrium, Goldman equation)

L10. Channels, amplification, signal gating, and patch clamp Y4

L11. Action potentials and impulse propagation

L12. Functional electric stimulation and recording
   - MEA and CMOS based recording
   - Applying potential in liquid - simulation of fields and relevance to electric stimulation

L13. Neural networks memory and learning

**Literature**
- Plonsey and Barr, Bioelectricity: A Quantitative Approach (Third edition)
- Supervised exercises solving real-world problems. Some Matlab based exercises in groups.

**Abstract**

**Objective**
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

**Content**
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary pre-processing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

**Lecture notes**
Course material Script, computer demonstrations, exercises and problem solutions

**Prerequisites / notice**
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W 6</td>
<td>3V+1U</td>
</tr>
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<td></td>
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<td>L. Van Gool, O. Göksel, E. Konukoglu</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0965-00L</td>
<td>Micro and Nano-Tomography of Biological Tissues</td>
<td>W 4</td>
<td>3G</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>M. Stamparoni, P. A. Kaestner</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

**Objective**
Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

**Content**
Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.
### Surfaces, Interfaces and their Applications I

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>ECTS</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0969-00L</td>
<td>Methods &amp; Models for IMRI Data Analysis</td>
<td>W</td>
<td>6</td>
<td>4V</td>
<td>K. E. Stephan</td>
</tr>
<tr>
<td>327-0505-00L</td>
<td>Surfaces, Interfaces and their Applications I</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>N. Spencer, M. P. Heuberger, L. Isa</td>
</tr>
</tbody>
</table>

### Microscopy Training SEM I - Introduction to SEM

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>ECTS</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-2125-00L</td>
<td>Microscopy Training SEM I - Introduction to SEM</td>
<td>W</td>
<td>1</td>
<td>3P</td>
<td>S. Rodighiero, A. G. Bittermann, K. Kunze, J. Reuteler</td>
</tr>
<tr>
<td>327-2126-00L</td>
<td>Microscopy Training TEM I - Introduction to TEM</td>
<td>W</td>
<td>1</td>
<td>3P</td>
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</table>

### Literature

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<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>ECTS</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0505-00L</td>
<td>Surfaces, Interfaces and their Applications I</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>N. Spencer, M. P. Heuberger, L. Isa</td>
</tr>
</tbody>
</table>

### Prerequisites / notice

- **Number of participants limited to 6.**
- **Prerequisites:**
  - General undergraduate physics
  - General undergraduate chemistry
  - Introduction to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most important techniques that can be used to characterize surfaces. Later, liquid interfaces are treated, followed by an introduction to the fields of tribology (friction, lubrication, and wear) and corrosion.

### Objective

To obtain in-depth knowledge of the theoretical foundations of SPM and DCM and of their application to empirical IMRI data.

### Content

This course teaches state-of-the-art models and methods for IMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. pre-processing, the general linear model, frequentist and Bayesian inference, multiple comparison corrections, and event-related designs, and dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data. A particular emphasis of the course will be on mathematical questions arising in the context of studies in psychiatry, neurology, and neuroeconomics.

### Literature

- **Script Download:**
  - https://www.ethz.ch/content/specialinterest/mat/education/SI-A-1.html


- **Lecture notes**
  - Script (20 CHF)

### Objective

To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.

### Content

- Introduction to Surface Science
- Physical Structure of Surfaces
- Surf ace Forces (static and dynamic)
- Adsorbates on Surfaces
- Surface Thermodynamics and Kinetics
- The Solid-Liquid Interface
- Electron Spectroscopy
- Vibrational Spectroscopy on Surfaces
- Scanning Probe Microscopy
- Introduction to Tribology
- Introduction to Corrosion Science

### Prerequisites / notice

- **Chemistry:**
  - General basic chemical kinetics and thermodynamics

- **Physics:**
  - General basic physics

### Literature


### Objective

The introductory course on Scanning Electron Microscopy (SEM) emphasizes hands-on learning. Using 2 SEM instruments, students have the opportunity to study their own samples, or standard test samples, as well as solving exercises provided by ScopeM scientists.

### Content

- **Number of participants limited to 6.**
- **Abstract**
  - The participants will be chosen based on a short motivation letter. Please send this letter to S. Rodighiero (main lecturer) as soon as possible.

- **Objective**
  - Set-up, align and operate a SEM successfully and safely.
  - Master the operation of a low-vacuum and field-emission SEM and EDX instrument.
  - Perform sample preparation with corresponding techniques and equipment for imaging and analysis
  - Acquire techniques in obtaining secondary electron and backscatter electron micrographs
  - Perform EDX qualitative and semi-quantitative analysis

- **Content**
  - **During the course, students learn through lectures, demonstrations, and hands-on sessions how to setup and operate SEM instruments, including low-vacuum and low-voltage applications.**
  - This course gives basic skills for students new to SEM. At the end of the course, students with no prior experience are able to align a SEM, to obtain secondary electron (SE) and backscatter electron (BSE) micrographs and to perform energy dispersive X-ray spectroscopy (EDX) qualitative and semi-quantitative analysis. The procedures to better utilize SEM to solve practical problems and to optimize SEM analysis for a wide range of materials will be emphasized.

- Discussion of students' sample/interest
- Introduction and discussion on Electron Microscopy and instrumentation
- Lectures on electron sources, electron lenses and probe formation
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM
- Brief description and demonstration of the SEM microscope
- Practice on beam/specimen interaction, image formation, image contrast (and image processing)
- Student participation on sample preparation techniques
- Scanning Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.
- Lecture and demonstrations on X-ray micro-analysis (theory and detection), qualitative and semi-quantitative EDX and point analysis, linescans and spectral mapping
- Practice on real-world samples and report results

### Literature

- **Detailed course manual**
- **Egerton: Physical Principles of Electron Microscopy: an introduction to TEM, SEM and AEM, Springer Verlag, 2007**

### Prerequisites / notice

- **No mandatory prerequisites.** Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

### Notice

The participants will be chosen based on a short motivation letter. Please send this letter to S. Rodighiero (main lecturer) as soon as possible.

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We'll prepare you to produce your MSc thesis. You'll learn how to structure your thesis, write scientific English, and manage your writing.

The goal of this course is to engage students in a multidisciplinary collaboration to tackle real world problems. Following a design thinking approach, students will work in teams to solve a set of design challenges that are organized as a one-week, a three-week, and a final six-week project in collaboration with an external project partner.

Additionally please enrol via mystudies. Places will be assigned after the first lecture on the basis of your motivation letter and commitment for the class.

The introductory course on Transmission Electron Microscopy (TEM) provides theoretical and hands-on learning for new operators, utilizing lectures, demonstrations, and hands-on sessions.

Using two Transmission Electron Microscopes the students learn how to align a TEM, select parameters for acquisition of images in bright field (BF) and dark field (DF), perform scanning transmission electron microscopy (STEM) imaging, phase contrast imaging, and acquire electron diffraction patterns. The participants will also learn basic and advanced use of digital cameras and digital imaging methods.

Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding. This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

The course covers the writing context; the writing process; structuring sentences, paragraphs, longer sections (such as introduction, methods, results, and discussion), and whole texts; presenting and integrating non-textual elements such as graphs and tables; and editing and correcting drafts and proofs. Each lesson comprises a mixture of elements, including specialist input, individual tasks, pairwork, and groupwork. Active participation is expected.

No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551- 1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

- Introduction and discussion on Electron Microscopy and instrumentation.
- Lectures on electron sources, electron probe and image formation.
- Lectures on sample preparation techniques for EM.
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Demonstrations on Transmission Electron Microscopy Imaging modes (Phase contrast, BF, DF, STEM).
- Observation of TEM samples.
- Transmission Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.
- TEM alignment, calibration, correction to improve image contrast and quality.
- Electron diffraction.
- Practice on real-world samples and report results.
- Detailed course manual
The purpose of this course is to equip the students with methods and tools to tackle a broad range of problems. Following a Design Thinking approach, the students will learn how to observe and interact with key stakeholders in order to develop an in-depth understanding of what is truly important and emotionally meaningful to the people at the center of a problem. Based on these insights, the students ideate on possible solutions and immediately validated them through quick iterations of prototyping and testing using different tools and materials. The students will work in multidisciplinary teams on a set of challenges that are organized as a one-week, a three-week, and a final six-week project with an external project partner. In this course, the students will learn about the different Design Thinking methods and tools that are needed to generate deep insights, to engage in collaborative ideation, rapid prototyping and iterative testing.

Design Thinking is a deeply human process that taps into the creative abilities we all have, but that get often overlooked by more conventional problem solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as functional, and to express ourselves through means beyond words or symbols. Design Thinking provides an integrated way by incorporating tools, processes and techniques from design, engineering, the humanities and social sciences to identify, define and address diverse challenges. This integration leads to a highly productive collaboration between different disciplines.

Prerequisites / notice

For more information and the application visit: http://sparklabs.ch/ethz

Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

376-1103-00L Frontiers in Nanotechnology

<table>
<thead>
<tr>
<th>W</th>
<th>4 credits</th>
<th>V. Vogel, further lecturers</th>
</tr>
</thead>
</table>

Abstract

Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.

Objective

Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.

The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges they are currently fuzzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Each lecturer will first give an overview of the state-of-the art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

Content

Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived, to finally discussing biomedical applications and potential health risk issues. Scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

Lecture notes

All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

376-1177-00L Human Factors I

<table>
<thead>
<tr>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>M. Menozzi Jäckli, R. Huang, M. Siegrist</th>
</tr>
</thead>
</table>

Abstract

Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective

The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content

- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry, Digital Human Models
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature

- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students
- Further textbooks are introduced in the lecture
- Brouchures, checklists, key articles etc. are uploaded in ILIAS

376-1179-00L Applications of Cybernetics in Ergonomics

<table>
<thead>
<tr>
<th>W</th>
<th>1 credit</th>
<th>1U</th>
<th>M. Menozzi Jäckli, Y.Y. Hedinger Huang, R. Huang</th>
</tr>
</thead>
</table>

Abstract

Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involving the performance in multi-model interactions, quantification in gestalt principles in product development, or the information processing matter.

Objective

To learn and practice cybernetics principles in interface designs and product development.

Content

- Fitt's law applied in manipulation tasks
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection
- Accommodationvergence crosslink function
- Cross-link models in neurobiology- the ocular motor control system
- Human performance in optimization of production lines

Literature


376-1219-00L Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>2V</th>
<th>R. Rieener, R. Gassert, L. Marchal Crespo</th>
</tr>
</thead>
</table>

Abstract

Rehabilitation Eng is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.
Objective

Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

Content

Introduction, problem definition, overview
- Rehabilitation of visual function
  - Anatomy and physiology of the visual sense
  - Technical aids (glasses, sensor substitution)
  - Retina and cortex implants
- Rehabilitation of hearing function
  - Anatomy and physiology of the auditory sense
  - Hearing aids
  - Cochlea Implants
- Rehabilitation and use of kinesthetic and tactile function
  - Anatomy and physiology of the kinesthetic and tactile sense
  - Tactile/haptic displays for motion therapy (incl. electrical stimulation)
  - Role of displays in motor learning
- Rehabilitation of vestibular function
  - Anatomy and physiology of the vestibular sense
  - Rehabilitation strategies and devices (e.g. BrainPort)
- Rehabilitation of vegetative Functions
  - Cardiac Pacemaker
  - Phrenic stimulation, artificial breathing aids
  - Bladder stimulation, artificial sphincter
- Brain stimulation and recording
  - Deep brain stimulation for patients with Parkinson, epilepsy, depression
  - Brain-Computer Interfaces

Literature

Introductory Books:

Selected Journal Articles and Web Links:
- VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html
The objective of this course is to give an introduction to the fundamentals of physical human-robot interaction. Through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and de-sign safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements; 
2) compare and select mechatronic components that optimally fulfill the defined design requirements; 
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system; 
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup; 
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics; 
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://www.relab.ethz.ch/education/courses/phri/request-ethz-haptic-paddle-hardware-documentation.html), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.

Lecture notes
Will be distributed through the document repository before the lectures.
http://www.relab.ethz.ch/education/courses/phri.html
Literature


Notice:

The registration is limited to 26 students.

There are 4 credit points for this lecture.

The lecture will be held in English.

The students are expected to have basic control knowledge from previous classes.

http://www.relab.ethz.ch/education/courses/phi.html

Objective

Practical exercises and demonstrations on topics including sterile cell culture, light microscopy and histology, protein and gene expression analysis, and viability assays are covered. The advantages of 3D cell cultures will be discussed and practical work on manufacturing and evaluating hydrogels and scaffolds for tissue engineering will be performed in small groups. In addition to practical lab work, the course will teach skills in data acquisition/analysis.

Abstract

Practical Methods in Tissue Engineering

Number of participants limited to 12.

W 5 credits

4P K. Würtz-Kozak, M. Zenobi-Wong

Content

Clinical and Movement Biomechanics

Measurement and modeling of the human movement during daily activities and in a clinical environment.

W 4 credits

3G S. Lorenzetti, R. List, N. Singh

Objective

The goal of this course is to teach MSc students the necessary skills for doing research in the fields of tissue engineering and regenerative medicine.

Abstract

The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.

W 4 credits 2V+1U

K.U. Schmitt, M. H. Muser

Content

Trauma Biomechanics

Trauma biomechanics in an interdisciplinary research field investigating the biomechanics of injuries and related subjects such as prevention. The lecture provides an introduction to the basic principles of trauma biomechanics.

W 4 credits

B. Helgason, S. J. Ferguson, R. Müller, J. G. Shneider, B. Taylor, K. Würtz-Kozak, M. Zenobi-Wong

Objective

Introduction to the basic principles of trauma biomechanics.

This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact biomechanics, which uses the combination of fundamental engineering principles and advanced medical technologies to develop injury prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite element modelling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real world examples mainly from automobile safety are used to augment lecture material.

Handouts will be made available.

Literature


W 2 credits

2K

401-0629-00L

Applied Biostatistics

Principles and main methods in biostatistics with emphasis on practical aspects. Experimental and observational studies. Regression and analysis of variance. Introduction into survival analysis.

W 4 credits

3G M. Müller

Abstract

Getting an overwiew of the problems and statistical methods used in health sciences. Practise in using the software R to analyze data and interpreting the suits.
### 402-0674-00L

**Physics in Medical Research: From Atoms to Cells**

**W** 6 credits **2V+1U**

**B. K. R. Müller**

**Abstract**

Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

**Objective**

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

### 535-0423-00L

**Drug Delivery and Drug Targeting**

**W** 2 credits **2V**

**J.C. Leroux, D. Brambilla**

**Abstract**

The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand and evaluate the field in terms of scientific criteria.

**Objective**

The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. The focus of the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and constraints of their therapeutic usage, with prime attention on anticancer drugs, therapeutic peptides, proteins, nucleic acids and vaccines.

**Content**

The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

**Lecture notes**

Selected lecture notes, documents and supporting material will be directly provided or may be downloaded using

http://www.galenik.ethz.ch/teaching/drug_del_drug_targ

The website also displays additional information on peroral delivery systems, transdermal systems and systems for alternative routes (nasal, pulmonary) of delivery. These fields are covered in detail in the course Galenische Pharmazie II (Galenical Pharmacy II).

**Literature**


Further references will be provided in the course.

### 551-0317-00L

**Immunology I**

**W** 3 credits **2V**

**A. OXENIUS, M. KOPF**

**Abstract**

Introduction into structural and functional aspects of the immune system.

Basic knowledge of the mechanisms and the regulation of an immune response.

**Objective**

Introduction into structural and functional aspects of the immune system.

Basic knowledge of the mechanisms and the regulation of an immune response.

- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histocompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

**Lecture notes**

Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"
Lecturers

Translational Science for Health and Medicine
3 credits

Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Lecture notes

Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature

Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

636-0003-00L

Biological Engineering and Biotechnology

6 credits

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Objective

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to Development of Biological Weapons?
6. Functional Food. Enjoy your Meal!

Lecture notes

Handouts during the course.

Major in Molecular Health Sciences

Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0300-00L</td>
<td>Translational Science for Health and Medicine</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>J. Goldhahn, C. Wolfrum</td>
</tr>
</tbody>
</table>

Objective

After completing this course, students will be able to understand:

Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)

Content

What is translational science and what is it not?

How to identify need?

- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications

How to choose the appropriate research type and methodology

- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources

How to measure success?

- Outcome variables
- Improving the translational process

Challenges of communication?

- How independent is translational science?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

Electives

Elective Courses I

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0309-00L</td>
<td>Concepts in Modern Genetics</td>
<td>W</td>
<td>6</td>
<td>4V</td>
<td>Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voinnet</td>
</tr>
</tbody>
</table>

Abstract

Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective

This course focuses on the concepts of classical and modern genetics and genomics.
During the course, students learn through lectures, demonstrations, and hands-on sessions how to setup and operate SEM instruments.

**Lecturers**

The introductory course on Scanning Electron Microscopy (SEM) emphasizes hands-on learning. Using 2 SEM instruments, students have the opportunity to study their own samples, or standard test samples, as well as solving exercises provided by ScopeM scientists.

**Objective**

- Set-up, align and operate a SEM successfully and safely.
- Accomplish imaging tasks successfully and optimize microscope performances.
- Master the operation of a low-vacuum and field-emission SEM and EDS instrument.
- Perform sample preparation with corresponding techniques and equipment for imaging and analysis
- Acquire techniques in obtaining secondary electron and backscatter electron micrographs
- Perform EDX qualitative and semi-quantitative analysis

**Content**

During the course, students learn through lectures, demonstrations, and hands-on sessions how to setup and operate SEM instruments, including low-vacuum and low-voltage applications. This course gives basic skills for students new to SEM. At the end of the course, students with no prior experience are able to align a SEM, to obtain secondary electron (SE) and backscatter electron (BSE) micrographs and to perform energy dispersive X-ray spectroscopy (EDX) qualitative and semi-quantitative analysis. The procedures to better utilize SEM to solve practical problems and to optimize SEM analysis for a wide range of materials will be emphasized.

- Discussion of students’ sample interest
- Introduction and discussion on Electron Microscopy and instrumentation
- Lectures on electron sources, electron lenses and probe formation
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM
- Brief description and demonstration of the SEM microscope
- Practice on beam/specimen interaction, image formation, image contrast (and image processing)
- Student participation on sample preparation techniques
- Scanning Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities
- Lecture and demonstrations on X-ray micro-analysis (theory and detection), qualitative and semi-quantitative EDX and point analysis, linescans and spectral mapping
- Practice on real-world samples and report results

**Literature**

- K. Kunze, J. Reuteler

**Prerequisites / notice**

No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

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**Microscopy Training TEM I - Introduction to TEM**

Number of participants limited to 6.

The participants will be chosen based on a short motivation letter. Please send this letter to S. Rodighiero (main lecturer) as soon as possible.

**Abstract**

The introductory course on Transmission Electron Microscopy (TEM) provides theoretical and hands-on learning for new operators, utilizing lectures, demonstrations, and hands-on sessions.

**Objective**

- Overview of TEM theory, instrumentation, operation and applications.
- Alignment and operation of a TEM, as well as acquisition and interpretation of images, diffraction patterns, accomplishing basic tasks successfully.
- Knowledge of electron imaging modes (including Scanning Transmission Electron Microscopy), magnification calibration, and image acquisition using CCD cameras.
- To set up the TEM to acquire diffraction patterns, perform camera length calibration, as well as measure and interpret diffraction patterns.
- Overview of techniques for specimen preparation.

**Content**

Using two Transmission Electron Microscopes the students learn how to align a TEM, select parameters for acquisition of images in bright field (BF) and dark field (DF), perform scanning transmission electron microscopy (STEM) imaging, phase contrast imaging, and acquire electron diffraction patterns. The participants will also learn basic and advanced use of digital cameras and digital imaging methods.

- Introduction and discussion on Electron Microscopy and instrumentation.
- Lectures on electron sources, electron lenses and probe formation.
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM.
- Brief description and demonstration of the TEM microscope.
- Practice on beam/specimen interaction, image formation, Image contrast (and image processing).
- Demonstration of Transmission Electron Microscopes and imaging modes (Phase contrast, BF, DF, STEM).
- Student participation on sample preparation techniques.
- Transmission Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.
- TEM alignment, calibration, correction to improve image contrast and quality.
- Electron diffraction.
- Practice on real-world samples and report results.

**Literature**


**Prerequisites / notice**

No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.
This course provides a detailed understanding of the immune system. Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien".

The course covers the writing context; the writing process; structuring sentences, paragraphs, longer sections (such as introduction, methods, results, and discussion), and whole texts; presenting and integrating non-textual elements such as graphs and tables; and editing and correcting drafts and proofs. Each lesson comprises a mixture of elements, including specialist input, individual tasks, pairwork, and groupwork. Active participation is expected.

### 551-0223-00L Immunology III

**W 4 credits 2V**

**M. Kopf, M. Bachmann, J. Kisielow, A. Lanzavecchia, S. R. Leibundgut, A. Oxeniou, R. Spörri**

**Objective**

- Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
- Vaccines, immune-therapeutic interventions
- Hypersensitivities
- Allergies
- Th1 and Th2 cells, regulatory T cells
- Cytotoxic T cells and NK cells
- Autoimmunity
- Thymus and T cell selection
- Antigen presentation and Major Histoincompatibility (MHC) antigens
- Generation of diversity
- B cells and antibodies
- Innate and adaptive immunity, Cells and organs of the immune system
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter
- Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
- Overview of cytokines and their effector function
- Evolution of the "Danger" concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunction in acute and chronic viral infections

**Prerequisites / notice**

Immunology I and II recommended but not compulsory

### 551-0317-00L Immunology I

**W 3 credits 2V**

**A. Oxeniou, M. Kopf**

**Abstract**

Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

**Objective**

Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

**Content**

- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Thymic and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

**Prerequisites / notice**

Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

### 551-0512-00L Current Topics in Molecular and Cellular Neurobiology

**W 2 credits 1S**

**U. Suter**

**Number of participants limited to 8.**

**Abstract**

The course is a literature seminar or "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.

**Objective**

The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

**Content**

You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance. You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).
Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation

D. Bopp, E. Hafen

Presentations will be made available after the seminars.

Introduction to Glycobiology; M.E. Taylor, K. Drickamer, Oxford University Press, 2003

From DNA to Diversity (University of Zurich) W 2 credits 2V A. Hajnal, D. Bopp, E. Hafen

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: BIO336

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly
analysed model organisms.

Objective

By the end of this module, each student should be able to
- recognize the universal principles underlying the development of
different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved
to create animal diversity.
- relate changes in gene structure or function to evolutionary
changes in animal development.

Key skills:

By the end of this module, each student should be able to
- present and discuss a relevant evolutionary topic in an oral
presentation
- select and integrate key concepts in animal evolution from
primary literature
- participate in discussions on topics presented by others

Methods of Biological Analysis W 3 credits 3G R. Aebersold, M. Badertscher, K. Weis

Abstract

529-1042-00 Principles of the most important separation techniques and the interpretation of molecular spectra.

551-1003-00 The course will teach the basis and typical applications of methods for the analysis of nucleic acid sequences, mass spectrometric analysis of proteins and proteomes and advanced light and fluorescent imaging methods.

Objective

529-1042-00 Knowledge of the necessary basics and the possibilities of application of the relevant spectroscopic and separation methods in analytical
chemistry.

Content

529-1042-00 Application oriented basics of instrumental analysis in organic chemistry and the empirical employment of the methods of structure
elucidation (mass spectrometry, NMR-, IR-, UV/VIS spectroscopy). Basics and application of chromatographic and electrophoretic
separation methods. Application of the knowledge by practising.

551-1003-00 The course will consist of lectures covering the theoretical and technical base of the respective analytical methods and of exercises where
typical applications of the methods in modern experimental biology are discussed.

Lecture notes

529-1042-00 A comprehensive script is available in the HCI-Shop. A summary of the part "Spektroskopie" defines the relevant material for the exam.

551-1003-00 Materials supporting the lectures and exercises will be made available via Moodle.

Literature

529-1042-00
- Pretsch E., Bühlmann P., Badertscher M., Spektroskopische Daten zur Strukturaufklärung organischer Verbindungen, fünfte Auflage, Springer-Verlag, Berlin 2010;
- K. Cammann, Instrumentelle Analytische Chemie, Verfahren, Anwendungen, Qualitätssicherung, Spektrum Akademischer Verlag, Heidelberg, 2001;

551-1003-00 Principles of the most important separation techniques and the interpretation of molecular spectra.

Prerequisites / notice

529-1042-00
- 529-1001-01 V "Allgemeine Chemie I (für Biol./Pharm.Wiss."
- 529-1001-00 P "Allgemeine Chemie I (für Biol./Pharm.Wiss.)"
- 529-1011-00 G "Organische Chemie I (für Biol./Pharm.Wiss.)"

551-1105-00L Glycobiology W 4 credits 2V M. Aebi, T. Hennet

Abstract

Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and
glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the
glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

Objective

Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycobiology, in particular in the biosynthesis of glycoproteins and
glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of
lectins, 5) the role of glycans in infectious disease.

Content

Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality
control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious
disease

Lecture notes


<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Credits Type</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1145-00L</td>
<td>Viral and Non-Viral Vectors for Human Gene-Therapy - W from Pathogens to Safe Medical Applications</td>
<td>2</td>
<td>3V</td>
<td>University lecturers</td>
</tr>
<tr>
<td>551-1153-00L</td>
<td>Systems Biology of Metabolism W Number of participants limited to 15.</td>
<td>4</td>
<td>2V</td>
<td>U. Sauer, N. Zamboni, M. Zampieri</td>
</tr>
<tr>
<td>551-1171-00L</td>
<td>Immunology: from Milestones to Current Topics W</td>
<td>4</td>
<td>2S</td>
<td>B. Ludewig, J. Kisielow, M. Kopf, A. Owenius, University lecturers</td>
</tr>
<tr>
<td>551-1303-00L</td>
<td>Cellular Biochemistry of Health and Disease W Number of participants limited to 15.</td>
<td>4</td>
<td>2S</td>
<td>P. Picotti, Y. Barral, V. Korkhov, B. Kormann, R. Kroschewski, J. Matos, M. Peter, A. E. Smith, K. Weis</td>
</tr>
<tr>
<td>551-1323-00L</td>
<td>Fundamentals of Biology II: Biochemistry and Molecular Biology W</td>
<td>4</td>
<td>4V</td>
<td>K. Locher, N. Ban, R. Glockshuber, E. Weber-Ban</td>
</tr>
<tr>
<td>636-0003-00L</td>
<td>Biological Engineering and Biotechnology W</td>
<td>6</td>
<td>3V</td>
<td>M. Fussenegger</td>
</tr>
</tbody>
</table>

**Objective:** Knowledge of important viral and non-viral vector systems.

**Prerequisites / notice:** The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.
Students will read the primary literature on each topic, and in places we will use the following books:

- Schmid Hempel 2011 Evolutionary Parasitology
- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.

Objective
Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:
- stochastic models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics

Attendees will apply these concepts to a number of applications yielding biological insight into:
- epidemiology
- pathogen evolution
- macroevolution of species

Content
The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

Lecture notes
Slides of the lecture will be available online.
https://www.bsse.ethz.ch/cevo/education/cb-materials.html

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

636-0507-00L Synthetic Biology II

Objective
The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

Content
Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external), summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Lecture notes
Handouts during course

Prerequisites / notice
The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

701-1703-00L Evolutionary Medicine for Infectious Diseases

Objective
Students will learn to (i) identify evolutionary explanations for the origins and characteristics of infectious diseases in a range of organisms and (ii) evaluate ways of integrating evolutionary thinking into improved strategies for treating infections of humans and animals. This will incorporate principles that apply across any host-pathogen interaction, as well as system-specific mechanistic information, with particular emphasis on bacteria and viruses.

Content
We will cover several topics where evolutionary thinking is relevant to understanding or treating infectious diseases. This includes: (i) determinants of pathogen host range and virulence, (ii) dynamics of host-parasite coevolution, (iii) pathogen adaptation to evade or suppress immune responses, (iv) antimicrobial resistance, (v) evolution-proof medicine. For each topic there will be a short (< 30 minutes) introductory lecture, before students independently research the primary literature and develop half a page of discussion points and questions, followed by interactive discussion in class.

Literature
Schmid Hempel 2011 Evolutionary Parasitology
Stearns & Medzhitov 2016 Evolutionary Medicine

Prerequisites / notice
A basic understanding of evolutionary biology, microbiology or parasitology will be advantageous but is not essential.
The module Epidemiology and Prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.

Objective
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

Content
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophages for both diagnostics and antimicrobial intervention.

Lecture notes
Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

Literature
Recommendations will be given in the first lecture

Prerequisites / notice
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!

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**Major in Neurosciences**

**Compulsory Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0300-00L</td>
<td>Translational Science for Health and Medicine</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>J. Goldhahn, C. Wolfrum</td>
</tr>
</tbody>
</table>

Abstract
Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

Objective
After completing this course, students will be able to understand:
- Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)

Content
- What is translational science and what is it not?
- How to identify need?
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
- How to measure success?
- Outcome variables
- Improving the translational process
- Challenges of communication?
- How independent is translational science?
- Academic boundary conditions vs. industrial influences
- Positive and negative examples will be illustrated by distinguished guest speakers.

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**Electives**

**Elective Courses I**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1305-00L</td>
<td>Development of the Nervous System</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>E. Stoecckl, further lecturers</td>
</tr>
</tbody>
</table>

Abstract
The course covers the development of the nervous system (NS) with a focus on neurogenesis and migration, axon growth, synapse formation, mol. & cell. mechanisms, and diseases of the developing NS.
The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

Objective
This course focuses on the concepts of classical and modern genetics and genomics.

Content
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes
Scripts and additional material will be provided during the semester.

Literature
The course requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

Prerequisites / notice
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hönggerberg, and on Tuesday morning at UZH Irchel.

Number	Title	Type	ECTS	Hours	Lecturers
151-0104-00L	Uncertainty Quantification for Engineering & Life Sciences	W	4 credits	3G	P. Koumoutsakos
Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

227-0447-00L	Image Analysis and Computer Vision	W	6 credits	3V+1U	L. Van Goor, O. Gökse, E. Konukoglu
Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites / notice
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.
K.A. Martin, A. Gamma

It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote.

1. History of Neuroscience
   - It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote.

2. Basic Concepts of Neuroscience
   - The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

3. Neural Network Models
   - Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocularities of physics, math, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to solving these.

4. Consciousness
   - This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

5. Readings
   - Readings in Neuroinformatics (University of Zurich)
   - Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. We will read both original papers and explore the conceptual links between them and discuss the ‘sociology’ of science, the pursuit of basic science questions over a century of research.
   - This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

6. Assessment
   - Assessment will in the form of a written exam in which the students will be expected to explain a figure, technique, or concept.
   - Each week the course members will be given original papers to read for homework, they will have to write a short abstract for each paper. We will then meet weekly with the course leader (KACM) and an assistant for an hour-or-so long interactive seminar. An intimate knowledge of the papers will be assumed so that the discussion does not center simply on an explication of the contents of the papers.
327-2125-00L  Microscopy Training SEM I - Introduction to SEM  ■  W  1 credit  3P  S. Rodighiero, A. G. Bittermann, K. Kunze, J. Reuteler

Abstract: The introductory course on Scanning Electron Microscopy (SEM) emphasizes hands-on learning. Using 2 SEM instruments, students have the opportunity to study their own samples, or standard test samples, as well as solving exercises provided by ScopeM scientists.

Objective: During the course, students learn through lectures, demonstrations, and hands-on sessions how to setup and operate SEM instruments, including low-vacuum and low-voltage applications. This course gives basic skills for students new to SEM. At the end of the course, students with no prior experience are able to align a SEM, to obtain secondary electron (SE) and backscatter electron (BSE) micrographs and to perform energy dispersive X-ray spectroscopy (EDX) qualitative and semi-quantitative analysis. The procedures to better utilize SEM to solve practical problems and to optimize SEM analysis for a wide range of materials will be emphasized.

Content: - Discussion of students’ sample/interest
- Introduction and discussion on Electron Microscopy and instrumentation
- Lectures on electron sources, electron lenses and probe formation
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM
- Brief description and demonstration of the SEM microscope
- Practice on beam/specimen interaction, image formation, image contrast (and image processing)
- Student participation on sample preparation techniques
- Scanning Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities
- Lecture and demonstrations on X-ray micro-analysis (theory and detection), qualitative and semi-quantitative EDX and point analysis, line scans and spectral mapping
- Practice on real-world samples and report results
- Detailed course manual

No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

327-2126-00L  Microscopy Training TEM I - Introduction to TEM  ■  W  1 credit  3P  K. Kunze, J. Reuteler

Abstract: The introductory course on Transmission Electron Microscopy (TEM) provides theoretical and hands-on learning for new operators, utilizing lectures, demonstrations, and hands-on sessions.

Objective: - Overview of TEM theory, instrumentation, operation and applications.
- Alignment and operation of a TEM, as well as acquisition and interpretation of images, diffraction patterns, accomplishing basic tasks successfully.
- Knowledge of electron imaging modes (including Scanning Transmission Electron Microscopy), magnification calibration, and image acquisition using CCD cameras.
- To set up the TEM to acquire diffraction patterns, perform camera length calibration, as well as measure and interpret diffraction patterns.
- Overview of techniques for specimen preparation.

Content: Using two Transmission Electron Microscopes the students learn how to align a TEM, select parameters for acquisition of images in bright field (BF) and dark field (DF), perform scanning transmission electron microscopy (STEM) imaging, phase contrast imaging, and acquire electron diffraction patterns. The participants will also learn basic and advanced use of digital cameras and digital imaging methods.

- Introduction and discussion on Electron Microscopy and instrumentation.
- Lectures on electron sources, electron lenses and probe formation.
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM.
- Brief description and demonstration of the TEM microscope.
- Practice on beam/specimen interaction, image formation, image contrast (and image processing).
- Demonstration of Transmission Electron Microscopes and imaging modes (Phase contrast, BF, DF, STEM).
- Student participation on sample preparation techniques.
- Transmission Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.
- TEM alignment, calibration, correction to improve image contrast and quality.
- Electron diffraction.
- Practice on real-world samples and report results.
- Detailed course manual

No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

376-0221-00L  Methods and Concepts in Human Systems Neuroscience and Motor Control  ■  W  3 credits  3P  N. Wenderoth

Abstract: This course provides hands-on experience with measurement and analysis methods relevant for Humans Systems Neuroscience and Motor control (nerve/brain stimulation, EMG, EEG, psycho-physical paradigms etc). Students read scientific material, set up experiments, perform measurements in the lab, analyse data, apply statistics and write short reports or essays.

Number of participants limited to 16.
This course will prepare students for experimental work as it is typically done during the master thesis. The goal is to gain hands-on experience with measurement and analysis methods relevant for Humans Systems Neuroscience and Motor control (for example peripheral nerve stimulation, electrical and magnetic brain stimulation, EMG, EEG, psycho-physical paradigms etc). Students will learn how to perform small scientific projects in this area. Students will work individually or in small groups and solve scientific problems which require them to perform measurements in human participants, extract relevant readouts from the data, apply appropriate statistics and interpret the results. They will also be required to write small essays and reports and they will get feedback on their writing throughout the course.

Prerequisites / notice
Students are required to have successfully completed the course “Neural control of movement and motor learning” and to have basic knowledge of applied statistics. Self-study material about applied statistics will be available at the beginning of the course and statistical knowledge will be tested (central element) in the second course week. Passing this test is a requirement for continuing the course. Students will have to solve scientific problems, requiring them to independently study scientific material, apply statistics and report their results in the form of written reports and essays. Assessments will be made on the basis of the completed theoretical and practical work that will be performed either in small groups or individually.

376-0815-00L Writing your Master's Thesis: Natural Sciences and Engineering C1-C2

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Number of participants limited to 15 (3 courses are available).

Abstract
We'll prepare you to produce your MSc thesis. You'll learn how to structure your thesis, write scientific English, and manage your writing efficiently. You'll receive detailed feedback on work in progress.

Objective
The course covers the writing context; the writing process; structuring sentences, paragraphs, longer sections (such as introduction, conclusion) and the development of an abstract. Writing skills will be trained in the writing of technical English and the critical discussion and support of written material. The course aims to improve students' writing skills and to give them an understanding of the different styles. By the end of the course students are able to plan, draft, and edit academic English papers and theses; structure and write clear texts in a style which is acceptable to their academic discourse community; manage the writing process efficiently; select formal vocabulary and use it in a generally accurate and correct manner; choose and use generally suitable grammatical structures, punctuation, and orthographic conventions, assess their own effectiveness as writers of academic English, and identify areas in which further development is needed.

Content
The course covers the writing context; the writing process; structuring sentences, paragraphs, longer sections (such as introduction, methods, results, and discussion), and whole texts; presenting and integrating non-textual elements such as graphs and tables; and editing and correcting drafts and proofs. Each lesson comprises a mixture of elements, including specialist input, individual tasks, pairwork, and groupwork. Active participation is expected.

376-1177-00L Human Factors I

Abstract
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective
The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry, Digital Human Models
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature
- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NBPdS as electronic version and for free to ETH students
- Further textbooks are introduced in the lecture
- Brouchures, checklists, key articles etc. are uploaded in ILIAS

376-1179-00L Applications of Cybernetics in Ergonomics

Abstract
Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involving the performance in multi-model interactions, quantification in gestalt principles in product development; or the information processing matter.

Objective
To learn and practice cybernetics principles in interface designs and product development.

Content
- Fitt's law applied in manipulation tasks
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection
- Accommodation vergence crosslink function
- Cross-link models in neurobiology- the ocular motor control system
- Human performance in optimization of production lines

Literature

376-1414-00L Current Topics in Brain Research (HS)

Abstract
Different national and international scientific guests are invited to present and discuss their actual scientific results.

Objective
To exchange scientific knowledge and data and to promote communication and collaborations among researchers. For students: Critical discussion of current research. Students aiming at getting a credit point for this colloquium choose one topic and write a critical essay on the presented research topic.

Content
Different scientific guests working in the field of molecular cognition, neurochemistry, neurornorphology and neurophysiology present their latest scientific results.

Literature
no handout

376-1504-00L Physical Human Robot Interaction (pHRI)

Number of participants limited to 26.

Abstract
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

Data: 06.11.2018 12:57
Autumn Semester 2016
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Objective

The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and de-sign safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

Content

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Students will attend laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://www.relab.ethz.ch/education/courses/phri/request-ethz-haptic-paddle-hardware-documentation.html), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.

Lecture notes

Will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/phri.html

Literature


Prerequisites / notice

Notice:
The registration is limited to 26 students.
There are 4 credit points for this lecture.
The lecture will be held in English.
The students are expected to have basic control knowledge from previous classes.

http://www.relab.ethz.ch/education/courses/phri.html

551-0317-00L ImmunoI

Abstract

Introduction into structural and functional aspects of the immune system.
Basic knowledge of the mechanisms and the regulation of an immune response.

Objective

Introduction into structural and functional aspects of the immune system.
Basic knowledge of the mechanisms and the regulation of an immune response.

http://www.relab.ethz.ch/education/courses/phri.html
Content
- Introduction and historical background
- Innate and adaptive immunity. Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histoincompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

Lecture notes
Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

Literature
- Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

Prerequisites / notice

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Hours</th>
<th>Faculty</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>U. Kutay, R. I. Enchev, B. Kommann, M. Peter, I. Zemp, further lecturers</td>
</tr>
<tr>
<td>551-1145-00L</td>
<td>Viral and non-Viral Vectors for Human Gene-Therapy</td>
<td>W</td>
<td>2</td>
<td>3V</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Abstract
- Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function, regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
- The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.
- The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content
- Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.
- Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Lecture notes
- Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature
- Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice
- To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Hours</th>
<th>Faculty</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-4009-00L</td>
<td>Molecular Biology of Foodborne Pathogens</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. Loessner, M. Schупpler</td>
</tr>
<tr>
<td>752-6403-00L</td>
<td>Nutrition and Performance</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>S. Mettler, M. B. Zimmermann</td>
</tr>
</tbody>
</table>

Abstract
- Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

Objective
- Knowledge of important viral and non-viral vector systems.
- Knowledge of application in human diseases.
- Knowledge of limiting factors.

Content
- Molecular biology of foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

Lecture notes
- Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

Literature
- Recommendations will be given in the first lecture

Prerequisites / notice
- Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!
General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

► Practical Training and Semester Project

Practical Training and Semester Project only for majors below-mentioned:
- Human Movement Science and Sport
- Health Technologies
- Molecular Health Sciences
- Neurosciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-2110-00L</td>
<td>Internship 12 Weeks (Research or Job Oriented)</td>
<td>W</td>
<td>15</td>
<td>34P</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>Practical Training Internships are either research-oriented for exercising scientific (laboratory) methods or job-related for giving insight into the future world of work (industry, services, school).</td>
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<tr>
<td>Objective</td>
<td>Students should exercise scientific working and/or get realistic insights into future jobs.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>This version of internships lasts for at least 12 weeks full time equivalent.</td>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>376-2111-00L</td>
<td>Internship 8 Weeks (Research or Job Oriented)</td>
<td>W</td>
<td>10</td>
<td>23P</td>
<td>Professors</td>
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<tr>
<td>Abstract</td>
<td>Practical Training Internships are either research-oriented for exercising scientific (laboratory) methods or job-related for giving insight into the future world of work (industry, services, school).</td>
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<tr>
<td>Objective</td>
<td>Students should exercise scientific working and/or get realistic insights into future jobs.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>This version of internships lasts for at least 8 weeks full time equivalent.</td>
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<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-2112-00L</td>
<td>Internship 4 Weeks (Research or Job Oriented)</td>
<td>W</td>
<td>5</td>
<td>11P</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>Practical Training Internships are either research-oriented for exercising scientific (laboratory) methods or job-related for giving insight into the future world of work (industry, services, school).</td>
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<tr>
<td>Objective</td>
<td>Students should exercise scientific working and/or get realistic insights into future jobs.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>This version of internships lasts for at least 4 weeks full time equivalent.</td>
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</tbody>
</table>

► GESS Science in Perspective

Recommended Science in Perspective (Type B) for D-HEST.

see Science in Perspective: Type A: Enhancement of Reflection Capability

see Science in Perspective: Language Courses ETH/UZH

► Research Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-2100-00L</td>
<td>Research Internship</td>
<td>O</td>
<td>15</td>
<td>36A</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>12-week internship intended for exercising (independent) scientific working.</td>
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<tr>
<td>Objective</td>
<td>Students shall exercise scientific working as preparation for their master thesis.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The Research Internship lasts for at least 12 weeks full time equivalent. It can be combined with the Master Thesis.</td>
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</table>

► Master’s Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-2000-00L</td>
<td>Master’s Thesis</td>
<td>O</td>
<td>30</td>
<td>71D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>
| Abstract      | Only students fulfilling the following criteria can start with their master thesis:
  a. successful completion of the bachelor programme;
  b. fulfillment of any additional requirements necessary to gain admission to the master programme. |
| Objective     | The students shall demonstrate their ability to carry out a structured, scientific piece of work independently. |
| Prerequisites / notice | The Master Thesis can only be started after the Bachelor Degree was obtained and/or master admission requirements have been fulfilled. |

► Course Units for Additional Admission Requirements

The courses below are only for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0253-AAL</td>
<td>Mathematics I &amp; II</td>
<td>E-</td>
<td>13</td>
<td>28R</td>
<td>A. Cannas da Silva</td>
</tr>
<tr>
<td>Abstract</td>
<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
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<tr>
<td></td>
<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
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<tr>
<td></td>
<td>Mathematics I covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.</td>
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<tr>
<td></td>
<td>Main focus of Mathematics II: multivariable calculus and partial differential equations.</td>
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</tbody>
</table>
Objective
Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.

Content
1. Linear Algebra and Complex Numbers:
systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.

2. Single-Variable Calculus:
review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.

3. Ordinary Differential Equations:
separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.

4. Multivariable Differential Calculus:
functions of several variables, partial differentiation, curves and surfaces in space, scalar and vector fields, gradient, curl and divergence.

5. Multivariable Integral Calculus:
multiple integrals, line and surface integrals, work and flow, Green, Gauss and Stokes theorems, applications.

6. Partial Differential Equations:
separation of variables, Fourier series, heat equation, wave equation, Laplace equation, Fourier transform.

Literature
- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).
- Thomas, G. B.: Thomas' Calculus, Parts 2 (Pearson Addison-Wesley).

Prerequisites / notice
Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.

Assistance:
Tuesdays and Wednesdays 17-19h, in Room HG E 41.
### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
High-Energy Physics (Joint Master with EP Paris)

Core Subjects

Core Courses in Theoretical Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0843-00L</td>
<td>Quantum Field Theory I</td>
<td>W</td>
<td>10</td>
<td>4V+2U</td>
<td>C. Anastasiou</td>
</tr>
</tbody>
</table>

Abstract
This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and special relativity.
Topics include:
- Relativistic quantum mechanics
- Quantisation of bosonic and fermionic fields
- Interactions in perturbation theory
- Scattering processes and decays
- Radiative corrections

Objective
The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.

Core Courses in Experimental Physics

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
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</tr>
</thead>
<tbody>
<tr>
<td>402-0891-00L</td>
<td>Phenomenology of Particle Physics I</td>
<td>W</td>
<td>10</td>
<td>3V+2U</td>
<td>A. Gehrmann-De Ridder, R. Walny</td>
</tr>
</tbody>
</table>

Abstract
Topics to be covered in Phenomenology of Particle Physics I:
- Relativistic kinematics
- Decay rates and cross sections
- The Dirac equation
- From the S-matrix to the Feynman rules of QED
- Scattering processes in QED
- Experimental tests of QED
- Hadron spectroscopy
- Unitary symmetries and QCD
- QCD and alpha_s running
- QCD in e^+e^- annihilation
- Experimental tests of QCD in e^+e^- annihilation

Objective
Introduction to modern particle physics

Content
Topics to be covered in Phenomenology of Particle Physics I:
- Relativistic kinematics
- Decay rates and cross sections
- The Dirac equation
- From the S-matrix to the Feynman rules of QED
- Scattering processes in QED
- Experimental tests of QED
- Hadron spectroscopy
- Unitary symmetries and QCD
- QCD and alpha_s running
- QCD in e^+e^- annihilation
- Experimental tests of QCD in e^+e^- annihilation

Literature
As described in the entity: Lernmaterialien

Electives

Optional Subjects in Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0715-00L</td>
<td>Low Energy Particle Physics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>A. S. Antognini, P. A. Schmidt-Wellenburg</td>
</tr>
</tbody>
</table>

Abstract
Low energy particle physics provides complementary information to high energy physics with colliders. In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today.

Objective
The course aims to provide an introduction to selected advanced topics in low energy particle physics with neutrons and muons.

Content
Besides the sensitivity to effects related with new physics (e.g. lepton flavor violation, symmetry violations, CPT tests, search for electric dipole moments, new low mass exchange bosons etc.), low energy physics provides the best test of QED (electron g-2), the best tests of bound-state QED (atomic physics and exotic atoms), precise determinations of fundamental constants, information about the CKM matrix, precise information on the weak and strong force even in the non-perturbative regime etc.

In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today. Starting from a general introduction on high intensity/high precision particle physics and the main characteristics of muons and neutrons and their production, we will then focus on the discussion of fundamental problems and ground-breaking experiments:
- Production and characteristics of muon and neutron beams
- Ultracold neutron production
- Measurement of the neutron lifetime and electric dipole moment
- The neutron in the gravitational field and its electric charge
- Muon and neutron decay correlations
- Lepton flavour violations with muons to search for new physics
- What atomic physics can do for particle physics and vice versa
- Laser experiments at accelerators
- From myonic hydrogen to the proton structure and bound-state QED
- From pionic hydrogen to the strong interaction and effective field theories
- etc.
**402-0725-00L** Experimental Methods and Instruments of Particle Physics

**Abstract**
Physics and design of particle accelerators.
Basics and concepts of particle detectors.
Track- and vertex-detectors, calorimetry, particle identification.
Special applications like Cherenkov detectors, air showers, direct detection of dark matter.
Simulation methods, readout electronics, trigger and data acquisition.
Examples of key experiments.

**Objective**
Acquire an in-depth understanding and overview of the essential elements of experimental methods in particle physics, including accelerators and experiments.

**Content**
1. Examples of modern experiments
2. Basics: Bethe-Bloch, radiation length, nucl. interaction length, fixed-target vs. collider, principles of measurements: energy- and momentum-conservation, etc
3. Physics and layout of accelerators
4. Charged particle tracking and vertexing
5. Calorimetry
6. Particle identification
7. Analysis methods: invariant and missing mass, jet algorithms, b-tagging
8. Special detectors: extended airshower detectors and cryogenic detectors
9. MC simulations (GEANT), trigger, readout, electronics

**Lecture notes**

**Prerequisites / notice**
Einführung in die Kern- und Teilchenphysik / Introduction to Nuclear- and Particle-Physics
### Abstract
Manifold, Riemannian metric, connection, curvature; Special Relativity; Lorentzian metric; Equivalence principle; Tidal force and spacetime curvature; Energy-momentum tensor, field equations, Newtonian limit; Post-Newtonian approximation; Schwarzschild solution; Mercury's perihelion precession, light deflection.

### Objective
Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.

### Literature
Suggested textbooks:
- C. Misner, K. Thorne and J. Wheeler: Gravitation
- S. Carroll - Spacetime and Geometry: An Introduction to General Relativity
- R. Wald - General Relativity
- S. Weinberg - Gravitation and Cosmology
- N. Straumann - General Relativity with applications to Astrophysics

### 402-0898-00L
**The Physics of Electroweak Symmetry Breaking**

**W 6 credits 2V+1U**

**Abstract**
The aim is to understand the need of physics beyond the Standard Model, the basics of field theory, and the techniques of model building in theories BSM and the elements of collider physics required to analyze their phenomenological implications. After an introduction to the SM and alternative theories of electroweak symmetry breaking, we will investigate these issues in the context of models with weakly coupled extra dimensions.

**Objective**
After the course the student should have a good knowledge of some of the most relevant theories beyond the Standard Model and have the techniques to understand those theories that have not been surveyed in the course. He or she should be able to compute the constraints on any model of new physics, its successes explaining current experimental data and its main phenomenological implications at colliders.

**Prerequisites / notice**
The former title of this course unit was "The Physics Beyond the Standard Model". If you already got credits for "The Physics Beyond the Standard Model" (402-0898-00L), you cannot get credits for "The Physics of Electroweak Symmetry Breaking" (402-0898-00L).

### 402-0899-65L
**Higgs Physics**

**W 6 credits 2V+1U M. Grazzini**

**Abstract**
The course introduces the theory and phenomenology of the recently discovered Higgs boson. With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

**Objective**
With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

**Content**
- Theory part:
  - the Standard Model and the mass problem: WW scattering and the no-lose theorem
  - the Higgs mechanism and its implementation in the Standard Model
  - radiative corrections and the screening theorem
  - theoretical constraints on the Higgs mass: the hierarchy problem
  - Higgs production in e+e- collisions
  - Higgs production at hadron colliders
  - Higgs decays to fermions and vector bosons
  - Higgs differential distributions, rapidity distribution, pt spectrum and jet vetoes
  - Higgs properties and beyond the Standard Model perspective
  - Outlook: The Higgs sector in weakly coupled and strongly coupled new physics scenarios.

- Experimental part:
  * Introductory material:
    - reminders of detectors/accelerators
    - reminders of statistics: likelihoods, hypothesis testing
    - reminders of multivariate techniques: Neural Networks, Decision Trees
  * Main topics:
    - pre-history (pre-LEP)
    - LEP1: measurements at the Z-pole
    - LEP2: towards the limit mH<114 GeV
    - TeVatron searches
    - LHC:
      -- main channels overview
      -- dissect on analysis
      -- combine information from all channels
      -- differential measurements
      -- off-shell measurements
    - Future:
      -- pseudo-observables / EFT
      -- Beyond Standard Model

**Literature**
- Higgs Hunter's Guide
  (by S. Dawson, J. Gunion, H. Haber and G. Kane)

**Prerequisites / notice**
Prerequisites: Quantum Field Theory I, Phenomenology of Particle Physics I

### 402-0777-00L
**Particle Accelerator Physics and Modeling I**

**W 6 credits 2V+1U A. Adelmann**

**Abstract**
This is the first of two courses, introducing particle accelerators from a theoretical point of view and covers state-of-the-art modeling techniques. It emphasizes the multidisciplinary aspect of the field, both in methodology (numerical and computational methods) and with regard to applications such as medical, industrial, material research and particle physics.

**Objective**
You understand the building blocks of particle accelerators. Modern analysis tools allows you to model state-of-the art particle accelerators. In some of the exercises you will be confronted with next generation machines. We will develop a Python simulation tool (AcceLEGrator) that reflects the theory from the lecture.
Content

Here is the rough plan of the topics, however the actual pace may vary relative to this plan.

- Particle Accelerators an Overview
- Relativity for Accelerator Physicists
- Building Blocks of Particle Accelerators
- Lie Algebraic Structure of Classical Mechanics and Applications to Particle Accelerators
- Symplectic Maps & Analysis of Maps
- Particle Tracking
- Linear & Circular Machines
- Cyclotrons
- Free Electron Lasers
- Collective effects in linear approximation
- Preview of Particle Accelerator Physics and Modeling II

Literature

Particle Accelerator Physics, H. Wiedemann, ISBN-13 978-3-540-49043-2, Springer


Prerequisites / notice

This lecture is also suited for PhD. students

402-0851-00L  QCD: Theory and Experiment  W  3 credits  3G  G. Dissertori, University lecturers

Abstract
An introduction to the theoretical aspects and experimental tests of QCD, with emphasis on perturbative QCD and related experiments at colliders.

Objective
Knowledge acquired on basics of perturbative QCD, both of theoretical and experimental nature. Ability to perform simple calculations of perturbative QCD, as well as to understand modern publications on theoretical and experimental aspects of perturbative QCD.

Content
- QCD Lagrangian and Feynman Rules
- QCD running coupling
- Parton model
- Altarelli-Parisi equations
- Basic processes
- Experimental tests at lepton and hadron colliders
- Measurements of the strong coupling constant

Literature
2) R. K. Ellis, W. J. Stirling, B. R. Webber : "QCD and Collider Physics" (Cambridge Monographs on Particle Physics, Nuclear Physics & Cosmology)

Prerequisites / notice

Will be given as block course, language: English.
For students of both ETH and University of Zurich.

402-0845-60L  Quantum Field Theory III: EFT and SUSY  W  6 credits  2V+1U  G. Isidori

Abstract
This course provides a comprehensive introduction to two advanced topics in Quantum Field Theory: Effective Field Theories (EFTs) and Supersymmetry (SUSY).

Content
In the first part we will discuss the basic concepts of EFTs, with particular attention to the concepts of decoupling of heavy degrees of freedom, matching and renormalization, chiral Lagrangians. The Standard Model viewed as an EFT will also be discussed as a specific application. The second part of the course is devoted to Supersymmetry, starting from the discussion of the SUSY algebra and its representations, to arrive, after the presentation of the superfield formalism, to the construction of the supersymmetric version of gauge field theories. A phenomenological discussion of the mechanisms of SUSY breaking and the construction of viable supersymmetric extensions of the Standard Model will also be presented.

Topics:
- Introduction to Effective Field Theories
- The Appelquist-Carrazone theorem
- The matching procedure
- Chiral Lagrangians
- The SM as an EFT
- The SUSY algebra
- Superspace and superfields
- Supersymmetric field theories
- Supersymmetric gauge theories
- Supersymmetry breaking
- The Minimal supersymmetric Standard Model

Literature
J. Wess and J. Bagger, "Supersymmetry and supergravity".
Mueller-Kirsten & Wiedemann, "Introduction to supersymmetry".

Prerequisites / notice

QFT-I (mandatory) and QFT-II (highly recommended).

402-0846-66L  The BFKL Equation Reloaded and the Multi-Regge Kinematics in QCD and in N=4 SYM  W  1 credit  2G  V. Del Duca

Abstract
The goal of the course is to help the audience to keep abreast of the strong advances there have been in the study of the high energy limit of scattering amplitudes in the last decade.

Objective
The goal of the course is to help the audience to keep abreast of the strong advances there have been in the study of the high energy limit of scattering amplitudes in the last decade.

Content
- the BFKL Hamiltonian as an integrable model
- the analytic structure of the Mueller-Navelet jet cross sections in QCD
- the analytic properties of N=4 SYM amplitudes in multi-Regge kinematics

Prerequisites / notice

Follow-up of the block course "An Introduction to the Perturbative Pomeron and to the BFKL Equation in QCD and in N=4 SYM"

Optional Subjects in Mathematics

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3531-00L</td>
<td>Differential Geometry I</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>U. Lang</td>
</tr>
</tbody>
</table>

This course counts as a core course in the Bachelor's
degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from neither 401-3531-00L Differential Geometry I nor 401-3532-00L Differential Geometry II for their Bachelor's degree still can have recognised this course for the Master's degree.

Furthermore, at most one of the three course units
401-3461-00L Functional Analysis I
401-3531-00L Differential Geometry I
401-3601-00L Probability Theory
can be recognised for the Master's degree in Mathematics or Applied Mathematics.

Abstract
Curves in $\mathbb{R}^n$, inner geometry of hypersurfaces in $\mathbb{R}^n$, curvature, Theorema Egregium, special classes of surfaces, Theorem of Gauss-Bonnet, Hyperbolic space. Differentiable manifolds, tangent bundle, immersions and embeddings, Sard's Theorem, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.

Objective
Introduction to elementary differential geometry and differential topology.

Content
- Differential geometry in $\mathbb{R}^n$: theory of curves, submanifolds and immersions, inner geometry of hypersurfaces, Gauss map and curvature, Theorema Egregium, special classes of surfaces, Theorem of Gauss-Bonnet, Poincaré Index Theorem.
- The hyperbolic space.
- Differential topology: differentiable manifolds, tangent bundle, immersions and embeddings in $\mathbb{R}^n$, Sard's Theorem, transversality, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.

Literature
- Differential Geometry in $\mathbb{R}^n$:
  - Manfredo P. do Carmo: Differential geometry of curves and surfaces
  - Wolfgang Kühnel: Differentialgeometrie. Curves-surfaces-manifolds
  - Christian Bär: Elementary differential geometry
  - Dennis Barden & Charles Thomas: An Introduction to Differential Manifolds
  - Victor Guillemin & Alan Pollack: Differential Topology
  - Morris W. Hirsch: Differential Topology

401-3461-00L Functional Analysis I

This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from neither 401-3461-00L Functional Analysis I nor 401-3462-00L Functional Analysis II for their Bachelor's degree still can have recognised this course for the Master's degree.

Furthermore, at most one of the three course units
401-3461-00L Functional Analysis I
401-3531-00L Differential Geometry I
401-3601-00L Probability Theory
can be recognised for the Master's degree in Mathematics or Applied Mathematics.

Abstract
Baire category; Banach and Hilbert spaces, bounded linear operators; three fundamental principles: Uniform boundedness, open mapping/closed graph theorem, Hahn-Banach; convexity; dual spaces; weak and weak* topologies; Banach-Alaoglu; reflexive spaces; compact operators and Fredholm theory; closed range theorem; spectral theory of self-adjoint operators in Hilbert spaces.

Lecture notes
Lecture Notes on "Funktionalanalysis I" by Michael Struwe

Proseminars and Semester Papers

Number Title Type ECTS Hours Lecturers
402-0717-MSL Particle Physics at CERN W 9 credits 18P F. Nessi-Tedaldi, W. Lustermann
402-0719-MSL Particle Physics at PSI (Paul Scherrer Institute) W 9 credits 18P C. Grab
402-0210-96L Proseminar Theoretical Physics: Solitons and Instantons in Condensed Matter W 9 credits 4S V. Geshkenbein
402-0217-MSL Theoretical Semester Project in a Group of the Physics Department W 9 credits 18A Supervisors
402-0215-MSL Experimental Semester Project in a Group of the Physics Department W 9 credits 18A Professors
Abstract
The aim of the project is to give the student experience in working in a research environment, carrying out physics experiments, analysing and interpreting the resulting data.

Prerequisites / notice

► GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-PHYS.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

► Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>402-2000-00L</td>
<td>Scientific Works in Physics</td>
<td>O</td>
<td>0 credits</td>
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<td>C. Grab</td>
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<td></td>
<td>Target audience:</td>
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<td>Master students who cannot document to have received an adequate training in working scientifically.</td>
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<td>Directive</td>
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<tr>
<td>Abstract</td>
<td>Literature Review: ETH-Library, Journals in Physics, Google Scholar; Thesis Structure: The IMRAD Model; Document Processing: LaTeX and BibTeX, Mathematical Writing, AVETH Survival Guide; ETH Guidelines for Integrity; Authorship Guidelines; ETH Citation Etiquettes; Declaration of Originality.</td>
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<tr>
<td>Objective</td>
<td>Basic standards for scientific works in physics: How to write a Master Thesis. What to know about research integrity.</td>
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<tr>
<th>Number</th>
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<tr>
<td>462-0900-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>57D</td>
<td>Supervisors</td>
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<td>Further information:</td>
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<td><a href="http://www.phys.ethz.ch/phys/education/master/msc-theses">www.phys.ethz.ch/phys/education/master/msc-theses</a></td>
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<tr>
<td>Abstract</td>
<td>The Master's thesis is normally conducted in the fourth semester and concludes the degree programme. With the Master's thesis students verify their ability to undertake independent and scientifically structured work in the area of high energy physics.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The time limit for completing the Master's thesis is six months.</td>
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</tbody>
</table>

High-Energy Physics (Joint Master with EP Paris) - Key for Type

| O          | Compulsory | E-  | Recommended, not eligible for credits |
| W+         | Eligible for credits and recommended | Z   | Courses outside the curriculum |
| W          | Eligible for credits | Dr  | Suitable for doctorate |

Key for Hours

| V          | lecture | P   | practical/laboratory course |
| G          | lecture with exercise | A   | independent project |
| U          | exercise | D   | diploma thesis |
| S          | seminar  | R   | revision course / private study |
| K          | colloquium | | |

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Computer Science (General Courses)

Computer Science for Non-Computer Scientists

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0834-00L</td>
<td>Information Systems for Engineers</td>
<td>Z</td>
<td>4</td>
<td>2V+1U</td>
<td>R. Marti</td>
</tr>
<tr>
<td>Abstract</td>
<td>Foundations of information systems from a user's viewpoint. The focus is on structured data: relational databases, the data language SQL, designing relational databases. Additional topics: Information Retrieval (searching documents), and estimating their relevance and authority with respect to free-text queries; XML as a format for data exchange; Characteristics and processing of &quot;Big Data&quot;</td>
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<tr>
<td>Objective</td>
<td>Following the course should enable students to</td>
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<tr>
<td></td>
<td>1. answer non-trivial queries on existing relational databases by formulating (entry-level) SQL statements, as well as to add new database content and to update or delete existing content,</td>
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<td>2. formalize facts as perceived in the real world in terms of the entity-relationship model, and derive a set of normalized relations (tables) which define the structure of a relational database</td>
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<td>3. explain how a database management system (DBMS) essentially works and what kind of services it provides</td>
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<td></td>
<td>4. understand how a web search engine such as Google basically works</td>
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<td>5. know and apply the core concepts to structure and query XML-documents</td>
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<td>6. list the characteristics of &quot;Big Data&quot; and know the basics of processing &quot;Big Data&quot;</td>
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<tr>
<td>Content</td>
<td>Die Lehrveranstaltung vermittelt Grundlagen und Konzepte von Informationssystemen aus der Sicht eines Anwenders.</td>
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<td>Im Zentrum stehen relationale Datenbanksysteme, die Abfrage- und Datenmanipulationssprache SQL, sowie der Entwurf bzw. die Strukturierung relationaler Datenbanken. Dieser Stoff wird auch in praktischen Übungen vertieft.</td>
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<td>Weitere Themen sind der Umgang mit unstrukturierten und semistrukturierten Daten, die Integration von Daten aus verschiedenen autonomen Informationssystemen, sowie eine Übersicht der Architektur von Datenbanksystemen.</td>
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<tr>
<td>Literature</td>
<td>Vorlesungsunterlagen (PowerPoint Folien, teilweise auch zusätzlicher Text) werden auf der Web-Site publiziert. Der Kauf eines Buches wird nicht vorausgesetzt.</td>
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<tr>
<td>Prerequisites / notice</td>
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</table>

252-0835-00L | Computer Science I | Z | 4 credits | 2V+2U | F. O. Friedrich |
| Abstract    | The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Taught language is C++. No programming experience is required. |
| Objective   | Primary educational objective is to learn programming with C++. When successfully attended the course, students have a good command of the mechanisms to construct a program. They know the fundamental control and data structures and understand how an algorithmic problem is mapped to a computer program. They have an idea of what happens "behind the scenes" when a program is translated and executed. Secondary goals are an algorithmic computational thinking, understanding the possibilities and limits of programming and to impart the way of thinking of a computer scientist. |
| Content     | The course covers fundamental data types, expressions and statements, (Limits of) computer arithmetic, control statements, functions, arrays, structural types and pointers. The part on object orientation deals with classes, inheritance and polymorphism, simple dynamic data types are introduced as examples. In general, the concepts provided in the course are motivated and illustrated with algorithms and applications. |
| Lecture notes | A script written in English will be provided during the semester. The script and slides will be made available for download on the course web page. |
| Prerequisites / notice | From AS 2013, an admission to the exam does not any more formally require an attending of the recitation sessions. Handing in solutions to the weekly exercise sheets is thus not mandatory, but we strongly recommend it. |
|             | Examination is a one hour-long written test. |

252-0839-00L | Informatics | Z | 2 credits | 2G | L. E. Fässler, M. Dahinden |
Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: modeling and simulations, visualizing multi-dimensional data, managing data with lists and tables and with relational databases, introduction to programming, universal methods for algorithm design.

- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

Lecture notes
All materials for the lecture are available at www.evim.ethz.ch

Prerequisites / notice
This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

Computer Science I
The course covers the basic concepts of computer programming.

Objective
- Basic understanding of programming concepts. Students will be able to write and read simple programs and to modify existing programs.
- Variables, Types, Control Statements, Procedures and Functions, Scoping, Recursion, dynamic Programmering, vectorisierte Programmierung, Effizienz.

Content
1. Modeling and simulations
2. Visualizing multidimensional data
3. Data management with lists and tables
4. Data management with a relational database
5. Introduction to macro programming
6. Introduction to programming with Python

Lecture notes
Lecture notes in English and Handouts in German will be distributed electronically along with the course.

Prerequisites / notice
This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

Algorithms and Complexity
Introduction: RAM machine, data structures; Algorithms: sorting, median, matrix multiplication, shortest paths, minimal spanning trees; Paradigms: divide & conquer, dynamic programming, greedy algorithms; Data Structures: search trees, dictionaries, priority queues; Complexity Theory: P and NP, NP-completeness, Cook's theorem, reductions.

Objective
After this course students know some basic algorithms as well as underlying paradigms. They will be familiar with basic notions of complexity theory and can use them to classify problems.

Content
- know universal methods for algorithm design.
- handle the complexity of real-world data,
- process and analyze real-world data from their subject of study,
- choose and apply appropriate tools from computer science,
- to control computer and automate processes of problem solving by programming,

Lecture notes
Ja. Wird zu Beginn des Semesters verteilt.

Foundations of Computer Science
The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.

Objective
The students learn to
- understand the role of computer science in science,
- control computer and automate processes of problem solving by programming,
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

Lecture notes
All materials for the lecture are available at www.gdi.ethz.ch

Prerequisites / notice
This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

Computer Science in Secondary School Mathematics
The goal of this lecture is an algorithmically oriented introduction to programming.

Objective
The students learn to
- Application oriented computer science basics.

Content
1. Modeling and simulations
2. Introduction to Programming with Python
3. Modeling and simulations
4. Introduction to Matrices with Matlab
5. Visualizing multidimensional data
6. Data management with lists and tables
7. Data management with a relational database
8. Universal methods for algorithm design

Lecture notes
All materials for the lecture are available at www.gdi.ethz.ch

Prerequisites / notice
This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 798 of 1571
The unit "Computer Science in Secondary School Mathematics" addresses key contributions of computer science to general education, the tight relations between the algorithmic and the mathematical way of thinking, and the thoughtful choice of computer science topics for high school mathematics classes.

Objective
The general goal of the course consists in presenting ways to teach fundamentals of computer science, which are closely related to contents and methods of mathematics. After attending the course unit, a mathematics teacher is able to teach selected fundamentals of computer science in mathematics classes.

Content
The main topics of the course unit "Computer Science in Secondary School Mathematics" represent a scientific and didactic added value for mathematics classes.

Lecture notes
In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester. Literature wird angegeben. Zusätzliche Unterlagen und Folien werden zur Verfügung gestellt.

The unit "Computer Science in Secondary School Mathematics" addresses key contributions of computer science to general education, the tight relations between the algorithmic and the mathematical way of thinking, and the thoughtful choice of computer science topics for high school mathematics classes.

Material
The general goal of the course consists in presenting ways to teach fundamentals of computer science, which are closely related to contents and methods of mathematics. After attending the course unit, a mathematics teacher is able to teach selected fundamentals of computer science in mathematics classes.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

The course covers the didactics of logic, of cryptography, of finite state automata, of computability and of the introduction to programming. The students develop the understanding of fundamental scientific concepts such as algorithm, program, complexity, determinism, computation, automata, verification, testing, security of a cryptosystem and secure communication. They reflect on ways to embed them into a scientifically sound and didactically sustainable mathematics course.

Lecturers

K. Freiermuth, J. Hromkovic, L. Keller und B. Steffen: Einführung in die Kryptologie: Lehrbuch für Unterricht und Selbststudium. Springer Vieweg; Auflage: 2 (2014);

J. Hromkovic: Berechenbarkeit: Logik, Argumentation, Rechner und Assembler, Unendlichkeit, Grenzen der Automatisierbarkeit. Vieweg+Teubner; Auflage: 1 (2011);

H.-J. Böckenhauer, J. Hromkovic: Formale Sprachen: Endliche Automaten, Grammatiken, lexikalische und syntaktische Analyse. Springer Vieweg; Auflage: 1 (Januar 2013);


Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>251-0100-00L</td>
<td>Computer Science Colloquium</td>
<td>E-</td>
<td>0</td>
<td>2K</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>Invited talks, covering the entire scope of computer science. External Listeners are welcome at no charge. A detailed schedule is published at the beginning of each semester.</td>
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<tr>
<td>Objective</td>
<td>Top international computer scientists take the floor at the distinguished computer science colloquium. Our guest speakers present impacting topics across various areas of the discipline. The colloquium series is held every semester and also includes inaugural and farewell lectures of the department’s professors. The colloquium is a noteworthy event for all graduate students. Outside attendance is equally welcome.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Eingeladene Vorträge aus dem gesamten Bereich der Informatik, zu denen auch Auswärtige kostenlos eingeladen sind. Zu Semesterbeginn erscheint jeweils ein ausführliches Programm.</td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-5960-00L</td>
<td>Colloquium on Mathematics, Computer Science, and Education</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>N. Hungerbühler, M. Akved, J. Hromkovic, H. Klemenz</td>
</tr>
<tr>
<td>Subject didactics for mathematics and computer science teachers.</td>
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</tr>
<tr>
<td>Abstract</td>
<td>Didactics colloquium</td>
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</tbody>
</table>

Computer Science (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>lecture</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
<td></td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</table>

ECTS European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.

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### First Year Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0131-00L</td>
<td>Linear Algebra</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>O. Imamoglu, O. Sorkine Hornung</td>
</tr>
</tbody>
</table>

**Abstract**

Application oriented introduction to linear algebra (vector spaces, linear transformations, matrices), matrix decompositions (LU, QR, eigenvalue, and singular value decomposition). Introduction to the programming environment Matlab.

**Objective**

Die Lernziele sind:

- die fundamentalen Konzepte der linearen Algebra gut zu verstehen
- in der Lage zu sein, mit Hilfe von Matlab Rechenaufgaben zu lösen
- Anwendungen der linearen Algebra in der Informatik kennenzulernen

**Content**

Linear Algebra. Linear systems of equations, vectors and matrices, norms and scalar products, LU decomposition, vector spaces and linear transformations, least squares problems, QR decomposition, determinants, eigenvalues and eigenvectors, singular value decomposition, applications.

**Lecture notes**

Lecture notes "Linear Algebra" (Gutknecht) in German, with English expressions for all technical terms.

**Prerequisites / notice**

The relevant high school material is reviewed briefly at the beginning.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0025-00L</td>
<td>Discrete Mathematics</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>U. Maurer</td>
</tr>
</tbody>
</table>

**Abstract**

Content: Mathematical reasoning and proofs, abstraction, Sets, relations (e.g. equivalence and order relations), functions, (un-)countability, number theory, algebra (groups, rings, fields, polynomials, subalgebras, morphisms), logic (propositional and predicate logic, proof calculi).

**Objective**

The primary goals of this course are (1) to introduce the most important concepts of discrete mathematics, (2) to understand and appreciate the role of abstraction and mathematical proofs, and (3) to discuss a number of applications, e.g. in cryptography, coding theory, and algorithm theory.

**Content**

See course description.

**Lecture notes**

available (in english)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0026-00L</td>
<td>Algorithms and Data Structures</td>
<td>O</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>P. Widmayer, M. Püschel</td>
</tr>
</tbody>
</table>

**Abstract**

This course is about fundamental algorithm design paradigms, classic algorithmic problems, and data structures. The connection between algorithms and data structures is explained for geometric and graph problems. For this purpose, fundamental graph theoretic concepts are introduced.

**Objective**

An understanding of the design and analysis of fundamental algorithms and data structures.

**Content**


**Literature**


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0027-00L</td>
<td>Introduction to Programming</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>T. Gross</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction to fundamental concepts of modern programming and operational skills for developing high-quality programs, including large programs as in industry. The course introduces software engineering principles with an object-oriented approach based.

**Objective**

Many people can write programs. The "Introduction to Programming" course goes beyond that basic goal: it teaches the fundamental concepts and skills necessary to perform programming at a professional level. As a result of successfully completing the course, students master the fundamental control structures, data structures, reasoning patterns and programming language mechanisms characterizing modern programming, as well as the fundamental rules of producing high-quality software. They have the necessary programming background for later courses introducing programming skills in specialized application areas.

**Content**

Basics of object-oriented programming, Objects and classes, Pre- and postconditions, class invariants, Design by Contract. Fundamental control structures. Assignment and References. Basic hardware concepts. Fundamental data structures and algorithms. Recursion, Inheritance and interfaces, introduction to event-driven design and concurrent programming. Basic concepts of Software Engineering such as the software process, specification and documentation, reuse and quality assurance.

**Lecture notes**

The lecture slides are available for download on the course page.

**Literature**

See the course page for up-to-date information.

**Prerequisites / notice**

There are no special prerequisites. Students are expected to enroll in the other courses offered to first-year students of computer science.

### First Year Examination Block 2

**Offered in the spring semester.**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0211-00L</td>
<td>Analysis I</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>not available</td>
</tr>
</tbody>
</table>

**Abstract**

The course unit will be offered again in the spring semester 2017.

**Objective**

Real and complex numbers, vectors, functions, limits, sequences, series, power series, differentiation and integration in one variable, introduction to ordinary differential equations.

**Content**

Real and complex numbers, vectors, functions, limits, sequences, series, power series, differentiation and integration in one variable, introduction to ordinary differential equations.

**Lecture notes**

Michael Struwe. _Analysis für Informatik._ ETH Zürich, 2010.

**Literature**


**Bachelor Studies (Programme Regulations 2008)**
### 3. Semester

#### Compulsory Courses (3. Sem.)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0057-00L</td>
<td>Theoretical Computer Science</td>
<td>O</td>
<td>8 credits</td>
<td>4V+2U+1A</td>
<td>J. Hromkovic</td>
</tr>
</tbody>
</table>

**Abstract**

Concepts to cope with: a) what can be accomplished in a fully automated fashion (algorithmically solvable) b) How to measure the inherent difficulty of tasks (problems) c) What is randomness and how can it be useful? d) What is nondeterminism and what role does it play in CS? e) How to represent infinite objects by finite automata and grammars?

**Objective**

Learning the basic concepts of computer science along their historical development

**Content**

This lecture gives an introduction to theoretical computer science, presenting the basic concepts and methods of computer science in its historical context. We present computer science as an interdisciplinary science which, on the one hand, investigates the border between the possible and the impossible and the quantitative laws of information processing, and, on the other hand, designs, analyzes, verifies, and implements computer systems.

The main topics of the lecture are:

- alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks
- finite automata, regular and context-free grammars
- Turing machines and computability
- complexity theory and NP-completeness
- design of algorithms for hard problems

**Lecture notes**

The lecture is covered in detail by the textbook "Theoretical Computer Science".

**Literature**

**Basic literature:**

**Further reading:**

**More exercises and examples in:**
6. A. Asteroth, Ch. Baier: Theoretische Informatik

**Prerequisites / notice**

During the semester, two non-obligatory test exams will be offered.

<table>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
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</thead>
<tbody>
<tr>
<td>252-0061-00L</td>
<td>Systems Programming and Computer Architecture</td>
<td>O</td>
<td>8 credits</td>
<td>4V+2U+1A</td>
<td>T. Roscoe</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction to computer architecture and system programming:

Instruction sets, storage hierarchies, runtime structures with an emphasis on computers as engines for the execution of compiled programs. Interaction between system software and the hardware. Problems that arise from the final representation, performance measurement and tuning, and program portability issues are covered.

**Objective**

The objective is to allow students to understand all aspects of the execution of compiled (C) programs on modern architectures -- the instruction set, the storage resources (registers, stack, memory), input/output, the impact of compiler decisions, and the interaction between the operating system and hardware. Two main themes are correctness issues (esp. those that arise from the finite representation of data) and performance issues (incl. measurement and tuning issues). The interface to the operating system is discussed to prepare for subsequent classes on more advanced systems topics.

The two key goals are:

1) To equip students with a thorough understanding of how to write correct programs that run fast on modern computer, and
2) How to write correct and efficient low-level systems code.

This course does not cover how to design or build a processor or computer.
Content

This course provides an overview of "computers" as a platform for the execution of (compiled) computer programs. This course provides a programmer’s view of how computer systems execute programs, store information, and communicate. The course introduces the major computer architecture structures that have direct influence on the execution of programs (processors with registers, caches, other levels of the memory hierarchy, supervisor/kernel mode, and I/O structures) and covers implementation and representation issues only to the extent that they are necessary to understand the structure and operation of a computer system.

The course attempts to expose students to the practical issues that affect performance, portability, security, robustness, and extensibility. This course provides a foundation for subsequent courses on operating systems, networks, compilers and many other courses that require an understanding of the system-level issues. Topics covered include: machine-level code and its generation by optimizing compilers, address translation, input and output, trap/event handlers, performance evaluation and optimization (with a focus on the practical aspects of data collection and analysis).

Literature

The course is based in part on "Computer Systems: A Programmer's Perspective" (2nd Edition) by R. Bryant and D. O'Hallaron, with some additional material.

Prerequisites / notice

252-0024-00L Parallel Programming, 252-0014-00L Digital Circuits

401-0613-00L Probability and Statistics

Objective

a) ability to understand the covered methods from probability theory and to apply them in other contexts
b) probabilistic thinking and stochastic modelling
c) ability to perform basic statistical tests and to interpret the results

Content

Basic concepts from probability and statistics with special emphasis on the topics needed in computer science

The conceptual goals are

- the laws of randomness and probabilistic thinking (thinking in probabilities)
- understanding and intuition for stochastic modelling
- simple and basic methods from statistics

The contents of the course encompasses

- an introduction to probability theory: basic concepts (probability space, probability measure), independence, random variables, discrete and continuous distributions, conditional probability, expectation and variance, limit theorems
- methods from statistics: parameter estimation, maximum likelihood and moment methods, tests, confidence intervals

Lecture notes

Lecture notes for the course (in German) will be made available electronically at the beginning of the course.

401-0663-00L Numerical Methods for CSE

Objective

* Knowledge of the fundamental algorithms in numerical mathematics
* Knowledge of the essential terms in numerical mathematics and the techniques used for the analysis of numerical algorithms
* Ability to choose the appropriate numerical method for concrete problems
* Ability to interpret numerical results
* Ability to implement numerical algorithms efficiently

Content

1. Direct Methods for linear systems of equations
2. Least Squares Techniques
3. Data Interpolation and Fitting
4. Filtering Algorithms
5. Approximation of Functions
6. Numerical Quadrature
7. Iterative Methods for non-linear systems of equations
8. Single Step Methods for ODEs
9. Stiff Integrators

Lecture notes

Lecture materials (PDF documents and codes) will be made available to participants:

Lecture Git repository: https://gitlab.math.ethz.ch/NumCSE/NumCSE
Tablet classroom notes: http://www.sam.math.ethz.ch/~grsam/HS16/NumCSE/NCSE16_Notes/
Lecture recording: http://www.video.ethz.ch/lectures/d-math/2016/autumn/401-0663-00L.html
Homework problems: https://people.math.ethz.ch/~grsam/HS16/NumCSE/NCSEProblems.pdf
Compensatory Courses

Compulsory major courses count as compensatory courses.

Major

Compulsory Major Courses

Major in Computer and Software Engineering

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
252-0210-00L | Compiler Design | O | 8 credits | 4V+3U | T. Gross

Abstract

This course uses compilers as example to expose modern software development techniques. Compiler organization, Lexical analysis, Top-down parsing via recursive descent, table-driven parsers, bottom-up parsing. Symboltables, semantic checking. Code generation for a simple RISC machine: conditionals, loops, procedure calls, simple register allocation techniques.

Objective

Learn principles of compiler design, gain practical experience designing and implementing a medium-scale software system.

Content

The course will be accompanied by programming exercises in C++ relying on the template library EIGEN. Familiarity with C++, object oriented and generic programming is an advantage. Participants of the course are expected to learn C++ by themselves.

Prerequisites / notice

Prior exposure to modern techniques for program construction, knowledge of at least one processor architecture at the assembly language level.

Literature


M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002

Prerequisites / notice

The course is designed for students with a background in computer science and software engineering. Prior exposure to modern techniques for program construction, knowledge of at least one processor architecture at the assembly language level, and familiarity with C++ and object-oriented programming are recommended. Participants of the course are expected to learn C++ by themselves.

Distributed Systems

252-0213-00L

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
252-0213-00L | Distributed Systems | O | 8 credits | 6G+1A | F. Mattern, R. Wattenhofer

Abstract

Distributed control algorithms (mutual exclusion, logical clocks), communication models (RPC, synchronous/asynchronous communication, broadcast, events, tuple spaces), middleware, service- and resource-oriented architectures (SOAP, REST), security, fault-tolerance (failure models, consensus), replication (primary copy, 2PC, 3PC, Paxos, quorum systems), shared memory (spin locks, concurrency).

Objective

Become acquainted with pertinent technologies and architectures of distributed systems.

Content

We present the characteristics and concepts of distributed systems, and discuss distributed control algorithms (flooding, mutual exclusion, logical clocks), communications models (remote procedure call, client-server models, synchronous and asynchronous communication), abstract communication principles (broadcast, events, tuple spaces), name services, communication middleware for open systems (e.g., REST, SOAP), infrastructure for ad hoc networking (JIN), cloud computing, and mechanisms for security and safety. Having a distributed system may permit getting away with failures and malfunctions of parts of the system. We discuss fault-tolerance issues (models, consensus, agreement) as well as replication issues (primary copy, 2PC, 3PC, Paxos, quorum systems, distributed storage) and problems with asynchronous multiprocessing (shared memory, spin locks, concurrency). To get familiar with message passing communication, some of the exercises will be devoted to a practical lab where participants will develop software for a mobile platform (smartphones).

Prerequisites / notice

The course is designed for students with a background in computer science and software engineering. Prior exposure to modern techniques for program construction, knowledge of at least one processor architecture at the assembly language level, and familiarity with C++ and object-oriented programming are recommended. Participants of the course are expected to learn C++ by themselves.

High Performance Computing for Science and Engineering (HPCESE I)

252-0205-00L

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
252-0205-00L | Visual Computing | O | 8 credits | 4V+3U | M. Gross, O. Hilliges

Abstract

This course acquaints students with core knowledge in computer graphics, image processing, multimedia and computer vision. Topics include: Graphics pipeline, perception and camera models, transformation, shading, global illumination, texturing, sampling, filtering, image representations, image and video compression, edge detection and optical flow.

Objective

This course provides an in-depth introduction to the core concepts of computer graphics, image processing, multimedia and computer vision. The course forms a basis for the specialization track Visual Computing of the CS master program at ETH.

Content

Course topics will include: Graphics pipeline, perception and color models, camera models, transformations and projection, projections, lighting, shading, global illumination, texturing, sampling theorem, Fourier transforms, image representations, convolution, linear filtering, diffusion, nonlinear filtering, edge detection, optical flow, image and video compression.

In theoretical and practical homework assignments students will learn to apply and implement the presented concepts and algorithms.

Lecture notes

A script will be handed out for a part of the course. Copies of the slides will be available for download. We will also provide a detailed list of references and textbooks.

Literature


151-0107-20L

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
151-0107-20L | High Performance Computing for Science and Engineering (HPCESE I) | W | 4 credits | 4G | M. Troyer, P. Chatzidoukas

Abstract

This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.
Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

⏳⏳⏳ Major in Theoretical Computer Science

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>252-0209-00L</td>
<td>Algorithms, Probability, and Computing</td>
<td>O</td>
<td>8 credits</td>
<td>4V+2U+1A</td>
<td>E. Welzl, M. Ghaffari, A. Steger, P. Widmayer</td>
</tr>
</tbody>
</table>

Abstract
Advanced design and analysis methods for algorithms and data structures: Random(ized) Search Trees, Point Location, Minimum Cut, Linear Programming, Randomized Algebraic Algorithms (matchings), Probabilistically Checkable Proofs (introduction).

Objective
Studying and understanding of fundamental advanced concepts in algorithms, data structures and complexity theory.

Literature
Will be handed out.

Electives
Compulsory major courses may also qualify as electives. Students may also choose courses from the Master's program in Computer Science. It is their responsibility to make sure that they meet the requirements and conditions for these courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-3110-00L</td>
<td>Human Computer Interaction</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>O. Hilliges, M. Norrie</td>
</tr>
</tbody>
</table>

Abstract
The course provides an introduction to the field of human-computer interaction, emphasising the central role of the user in system design. Through detailed case studies, students will be introduced to different methods used to analyse the user experience and shown how these can inform the design of new interfaces, systems and technologies.

Objective
The goal of the course is that students should understand the principles of user-centred design and be able to apply these in practice.

Content
The course will introduce students to various methods of analysing the user experience, showing how these can be used at different stages of system development from requirements analysis through to usability testing. Students will get experience of designing and carrying out user studies as well as analysing results. The course will also cover the basic principles of interaction design. Practical exercises related to touch and gesture-based interaction will be used to reinforce the concepts introduced in the lecture. To get students to further think beyond traditional system design, we will discuss issues related to ambient information and awareness.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0107-20L</td>
<td>High Performance Computing for Science and Engineering (HPCSE I)</td>
<td>W</td>
<td>4 credits</td>
<td>4G</td>
<td>M. Troyer, P. Chatzidoukas</td>
</tr>
</tbody>
</table>

Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0627-00L</td>
<td>Applied Computer Architecture</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>A. Gunzinger</td>
</tr>
</tbody>
</table>

Abstract
This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs.

Objective
Understand the function, the design and the performance modeling of parallel computer systems.

Content
The lecture "Applied Computer Architecture" gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits.
Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)?
Which architecture is behind the alarm center of the Swiss Railway (SBB)?
Which computer architectures are applied for driver assistance systems?
Which computer architecture is hidden behind a professional digital audio mixing desk?
How can data streams of about 30 TB/s, produced by a protone accelerator, be processed in real time?
Can the weather forecast also be processed with GPUs?
How can a good computer architecture be found?
Which are the driving factors in successful computer architecture design?
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties and vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.

227-1037-00L Introduction to Neuroinformatics

Objective
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monochromes of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

Content
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

252-4101-00L ACM-Lab

Objective
The objective of this course is to learn how to solve algorithmic problems given as descriptions in natural language, similar to those posed in ACM Programming Contests. This includes appropriate problem modeling, choice of suitable (combinatorial) algorithms, and their efficient implementation using C/C++ and the STL.

Seminar

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-2600-05L</td>
<td>Software Engineering Seminar</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Vechev</td>
</tr>
<tr>
<td>252-2610-00L</td>
<td>Foundations of Eiffel-Programming</td>
<td>Z</td>
<td>0</td>
<td>2G</td>
<td>H. Lehner</td>
</tr>
</tbody>
</table>

GESS Science in Perspective

Science in Perspective

Recommended Science in Perspective (Type B) for D-INFK.

see Science in Perspective: Type A: Enhancement of Reflection Capability
# Bachelor's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0500-00L</td>
<td>Bachelor's Thesis</td>
<td>O</td>
<td>10 credits</td>
<td>21D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

**Abstract**
The Bachelor thesis is the final requirement of the BSc program and is supervised by one of the D-INFK professors. The thesis encourages students to show and produce a scientifically structured work.

**Objective**
In their BSc thesis students should demonstrate their ability to carry out independent, structured scientific work.

**Prerequisites / notice**
The supervisor of the thesis defines the task, start and end date. A written report will be prepared on the scientific studies carried out, followed by a final presentation. The thesis must be handed in within 6 months.

---

### Computer Science Bachelor - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ECTS**
European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH). The colloquium is only apt for students who intend to enrol in the programs “Teaching Diploma” or “Teaching Certificate”. It is about learning in childhood and adolescence.

### Content

- Theoretical and methodological approaches to learning and teaching
- Evaluate and critically question the performance assessment that they employ in practice and professionalise it further.
- Learn to weigh the advantages and disadvantages of these approaches.
- Participants are exemplarily introduced to different research methods used in research on learning and instruction.
- Participants study the scientific fundamentals of test theory and test structure.
- Participants learn to describe the theoretical underpinnings of test theory and test structure.
- Participants learn to critically question the performance assessment that they employ in practice and professionalise it further.
- Participants are introduced to tests based on empirical research and to tests that are used in practice.

### Prerequisites / literature

- TheSeeMe data set (https://www.see-me.de/)
- Grundlagenliteratur zu Testtheorie und Teststrukturen
- P. Greutmann, further reading.

### Lecture notes

- Folien zur Verfügung gestellt.
- Elektronisches Lerntagebuch.
- Über die Bedeutung des Gelernten für den Schulalltag soll reflektiert werden.

### Lecture notes

- In this seminar students are put in a position where they can further educate themselves in the field of research into teaching and learning.
- The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH).
- The colloquium is only apt for students who intend to enrol in the programs “Teaching Diploma” or “Teaching Certificate”.
- It is about learning in childhood and adolescence.

### Prerequisites / notice

- The colloquium is only apt for students who intend to enrol in the programs “Teaching Diploma” or “Teaching Certificate”.
- It is about learning in childhood and adolescence.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
<tr>
<td>851-0240-03L</td>
<td>Introduction to Test Theory and Test Construction in</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>University lecturers</td>
</tr>
<tr>
<td></td>
<td>Educational Contexts (University of Zürich)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with Teaching Diploma or DC</td>
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<tr>
<td></td>
<td>matriculation.</td>
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</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>corresponding module directly at UZH.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UZH Module Code: 200a968</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>851-0240-16L</td>
<td>Colloquium on the Science of Learning and Instruction</td>
<td>W</td>
<td>1</td>
<td>1K</td>
<td>E. Stern, P. Greutmann, further lecturers</td>
</tr>
<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4)</td>
<td>W</td>
<td>2</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann, further lecturers</td>
</tr>
</tbody>
</table>
This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

**851-0242-06L**

**Cognitively Activating Instructions in MINT Subjects**

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
</tbody>
</table>

*Abstract*

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

*Objective*

- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

*Prerequisites / notice*

Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

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**851-0242-07L**

**Human Intelligence**

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
</tbody>
</table>

*Abstract*

The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

*Objective*

- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

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**851-0242-08L**

**Research Methods in Educational Science**

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
</tbody>
</table>

*Abstract*

The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

*Objective*

- Understanding research methods used in the empirical educational sciences
- Understanding and critically examine information from scientific journals and media
- Understanding pedagogically relevant findings from the empirical educational sciences

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**Subject Didactics and Professional Training**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>272-0101-00L</td>
<td>Subject Didactics of Computer Science I</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>G. Serafini, J. Hromkovic</td>
</tr>
</tbody>
</table>

*Abstract*

The unit "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course deals with the thoughtful choice of educational contents for computer science classes, which takes into account its comprehensibility for different age groups as well as didactic approaches suitable for a successful knowledge transfer.

*Objective*

The general objective of the course consists in highlighting the tight connection between the mathematical and algorithmic way of thinking and the approaches adopted by engineering disciplines, and in reflecting on teaching approaches for sustainable computer science teaching activities.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.
The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

### Prerequisites / notice

Lecture notes

Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Wird von der Praktikumslehrperson bestimmt.

### 271-0102-00L

**Teaching Internship Including Examination Lessons in Computer Science**

Teaching Internship Computer Science for TC and Teaching Diploma Computer Science as Minor Subject.

Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated.

**Abstract**

Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

**Objective**

- Students use their specialist-subject, educational-science and subject-didactics teaching to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

**Content**

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Literature**


### 272-0103-00L

**Mentored Work Subject Didactics Computer Science**

Mentored Work Subject Didactics in Computer Science for TC, Teaching Diploma and Teaching Diploma Computer Science as Minor Subject.

**Abstract**

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**

The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**

Thematic Schwerpunkte

Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen


**Literature**

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

**Prerequisites / notice**

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

▶ Specialized Courses in Respective Subject with Educational Focus
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>272-0400-00L</td>
<td>Mentored Work Specialised Courses in the Respective Subject with Educational Focus Computer Sc A</td>
<td>W+</td>
<td>2</td>
<td>4A</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.</td>
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<tr>
<td>Objective</td>
<td>The aim is for the students - to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way. - to independently develop a text with, special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership. - To try out different options for specialist further training in their profession.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt. Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.</td>
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<tr>
<td>Prerequisites / notice</td>
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</tr>
<tr>
<td>263-2800-00L</td>
<td>Design of Parallel and High-Performance Computing</td>
<td>W</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>T. Hoefler, M. Püschel</td>
</tr>
<tr>
<td>Abstract</td>
<td>Advanced topics in parallel / concurrent programming. Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.</td>
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<tr>
<td>Objective</td>
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<td>Content</td>
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<tr>
<td>Literature</td>
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<tr>
<td>Prerequisites / notice</td>
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</tr>
<tr>
<td>252-0341-01L</td>
<td>Information Retrieval</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>T. Hofmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation.</td>
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<tr>
<td>Objective</td>
<td>In depth understanding of managing, indexing, and retrieving documents with text, image and XML content. Knowledge about basic search algorithms on the web, benchmarking of search algorithms, and relevance feedback methods.</td>
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<tr>
<td>Content</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td></td>
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</tr>
<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>8</td>
<td>3V+2U+2A</td>
<td>J. M. Buhmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.</td>
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<tr>
<td>Objective</td>
<td>Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.</td>
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<tr>
<td>Content</td>
<td>The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.</td>
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<tr>
<td>Lecture notes</td>
<td>No lecture notes, but slides will be made available on the course webpage.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.</td>
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<tr>
<td>252-1407-00L</td>
<td>Algorithmic Game Theory</td>
<td>W</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>P. Widmayer, P. Penna</td>
</tr>
<tr>
<td>Abstract</td>
<td>Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.</td>
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<tr>
<td>Objective</td>
<td>Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.</td>
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</tbody>
</table>
The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classic game-theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization.
- Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the 'Price of Anarchy').
- Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium.
- Selected current research topics, such as Google's Sponsored Search Auction, the U.S. FCC Spectrum Auction, Kidney Exchange.

Lecture notes
No lecture notes.

Literature
"Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

Several copies of both books are available in the Computer Science library.

Prerequisites / notice
Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.
Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

252-0417-00L
Randomized Algorithms and Probabilistic Methods
7 credits
3V+2U+1A
W
Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks
A. Steger, E. Welzl

Objective
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Content
Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Lecture notes
Yes.

Literature

Computer Science TC - Key for Type
- O Compulsory
- W+ Eligible for credits and recommended
- W Eligible for credits
- E- Recommended, not eligible for credits
- Z Courses outside the curriculum
- Dr Suitable for doctorate

Key for Hours
- V lecture
- G lecture with exercise
- U exercise
- S seminar
- K colloquium
- P practical/laboratory course
- A independent project
- D diploma thesis
- R revision course / private study

ECTS European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
Computer Science Teaching Diploma

More informations at: https://www.ethz.ch/de/studium/didaktische-ausbildung/studienangebot-zulassung/lehrdiplom-fuer-maturitaetsschulen.html

► Computer Science as First Subject

★★ Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects ± W</td>
<td>2 credits</td>
<td>2S</td>
<td>R. Schumacher</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td>Objective</td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence ± W</td>
<td>1 credit</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<tr>
<td>Abstract</td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td>Objective</td>
<td>- Understanding research methods used in the empirical human sciences</td>
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<tr>
<td>Prerequisites / notice</td>
<td>- Getting to know intelligence tests</td>
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<td></td>
<td>- Understanding findings relevant for education</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science ± W</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td>Objective</td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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<tr>
<td>Abstract</td>
<td>The successful completion of both course no. 851-0240-00L &quot;Menschliches Lernen (EW 1)&quot; and course no. 851-0238-01L &quot;Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)&quot; is a necessary prerequisite for this course.</td>
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<tr>
<td>Objective</td>
<td>In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.</td>
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<tr>
<td>Learning goals include:</td>
<td>- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction.</td>
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<td>- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.</td>
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<td>- Participants can design and conduct a study that is relevant for answering their research question.</td>
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<td>- Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.</td>
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</tbody>
</table>

see Educational Science Teaching Diploma

► Subject Didactics in Computer Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>272-0101-00L</td>
<td>Subject Didactics in Computer Science ± W</td>
<td>4 credits</td>
<td>3G</td>
<td>G. Serafini, J. Hromkovic</td>
<td></td>
</tr>
<tr>
<td>Simultaneous enrolment in Introductory Practical in</td>
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</tbody>
</table>

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 812 of 1571
Computer Science - course 272-0201-00L is compulsory.

Abstract

The unit "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course deals with the thoughtful choice of educational contents for computer science classes, which takes into account its comprehensibility for different age groups as well as didactic approaches suitable for a successful knowledge transfer.

Objective

The general objective of the course consists in highlighting the tight connection between the mathematical and algorithmic way of thinking and the approaches adopted by engineering disciplines, and in reflecting on teaching approaches for sustainable computer science teaching activities.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

Content

The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

Lecture notes

Unterlagen und Folien werden zur Verfügung gestellt.


Prerequisites / notice

Mentored Work Subject Didactics in Computer Science for Teaching Diploma Computer Science as Minor Subject

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

The objective is to the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Themenatische Schwerpunkte

Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen


Literatur

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Prerequisites / notice

Mentored Work Subject Didactics in Computer Science for Teaching Diploma and for students upgrading TC to Teaching Diploma

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

Content

The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

Lecture notes

Unterlagen und Folien werden zur Verfügung gestellt.


Prerequisites / notice

Lehrdiplom-Studierende müssen diese Lerneinheit zusammen mit dem Einführungspraktikum Informatik - 272-0201-00L - belegen.
### Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>272-0201-00L</td>
<td>Introductory Practical in Computer Science ■</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
<tr>
<td></td>
<td>Simultaneous enrollment in Subject Didactics of Computer Science I - course 272-0101-00L - is compulsory.</td>
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</tr>
<tr>
<td>Abstract</td>
<td>During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and take five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.</td>
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<tr>
<td>Objective</td>
<td>Right from the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
<td></td>
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<tr>
<td>272-0202-00L</td>
<td>Professional Exercises ■</td>
<td>O</td>
<td>2</td>
<td>4U</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the course Professional Exercises the students achieve additional school-relevant experiences. The students carry out individually specified, practice related projects, in which they support, document or reflect on learning processes.</td>
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<tr>
<td>Objective</td>
<td>Achievement of additional school-relevant experiences. The students carry out individually specified, practice related projects, in which they support, document or reflect on learning processes.</td>
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<tr>
<td>Content</td>
<td>The course Professional Exercises offers the opportunity for additional school-relevant activities. The students are supported by the lecturers or by experienced teachers. They assist teachers at school, they create training systems and test, correct the written homework of pupils and evaluate the progress of a class. The students create explanations and detailed solutions to exercises with respect to the actual knowledge of the pupils. A written assignment states the exact scope of the activity.</td>
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<tr>
<td>Literature</td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
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</tr>
<tr>
<td>272-0203-00L</td>
<td>Teaching Internship in Computer Science ■</td>
<td>O</td>
<td>8</td>
<td>17P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
<tr>
<td>Abstract</td>
<td>The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.</td>
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<tr>
<td>Objective</td>
<td>- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.</td>
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<td></td>
<td>- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils.</td>
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<td>- They acquire the skills of the teaching trade.</td>
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<td>- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.</td>
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<td>- They learn to assess pupils' work.</td>
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<td>- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.</td>
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<tr>
<td>Literature</td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Findet in der Regel am Schluss der Ausbildung, vor Ablage der Prüfungslektionen statt.</td>
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</tr>
<tr>
<td>272-0204-00L</td>
<td>Teaching Internship for students upgrading TC to Teaching Diploma. ■</td>
<td>W</td>
<td>4</td>
<td>9P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is a supplement to the Teaching Internship required to obtain a Teaching Diploma in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.</td>
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<tr>
<td>Objective</td>
<td>Die Studierenden können die Bedeutung von Unterrichtsthemen in ihrem Fach unter verschiedenen Blickwinkeln einschätzen. Sie kennen und beherrschen das unterrichtliche Handwerk. Sie können ein gegebenes Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adäquate Lernumgebung umsetzen. Es gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu finden, sodass die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, um aktiv und effektiv flexibel nutzbares (Fach-)Wissen zu erwerben.</td>
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</table>
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening

Examination Lesson I in Computer Science

Simultaneous enrolment in "Examination Lesson II in Computer Science" (272-0205-02L) is compulsory.

Objective
On the basis of a specified topic, the candidate shows that they are in a position
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Content

Lecture notes / Prerequisites / notice


Teaching Diploma in 2 Subjects in One-Step Procedure: no courses from this category have to be completed.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
272-0401-00L | Mentored Work Specialised Courses in the Respective Subject with Educational Focus Computer Sc B | O | 2 credits | 4A | J. Hromkovic, G. Serafini

Abstract
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers in this way.

Objective
The aim is for the students
- to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialisation..
- to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership.
- To try out different options for specialist further training in their profession.

Content
Themenatische Schwerpunkte:

Lernformen:

Literature
Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

272-0401-00L | Mentored Work Specialised Courses in the Respective Subject with Educational Focus Computer Sc A | O | 2 credits | 4A | J. Hromkovic, G. Serafini

Abstract
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective
The aim is for the students
- to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialisation.
- to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership.
- To try out different options for specialist further training in their profession.
Thematic Schwerpunkte:

Lernformen:

Literatur Prerequisites / notice
Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt. Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

252-0341-01L Information Retrieval
W 4 credits 2V+1U T. Hofmann
Abstract
Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation.
Objective
In depth understanding of managing, indexing, and retrieving documents with text, image and XML content. Knowledge about basic search algorithms on the web, benchmarking of search algorithms, and relevance feedback methods.

252-0417-00L Randomized Algorithms and Probabilistic Methods
W 7 credits 3V+2U+1A A. Steger, E. Welzl
Abstract
Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, SSAT, card shuffling, random walks
Objective
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.
Content
Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.
Lecture notes
Yes.
Literature

252-0535-00L Machine Learning
W 8 credits 3V+2U+2A J. M. Buhmann
Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.
Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.
Content
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.
Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond
Lecture notes
No lecture notes, but slides will be made available on the course webpage.
Literature
Prerequisites / notice
The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

252-1407-00L Algorithmic Game Theory
W 7 credits 3V+2U+1A P. Widmayer, P. Penna
Abstract
Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.
Objective
Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.
The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don’t care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classic game-theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization.
- Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the ‘Price of Anarchy’).
- Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium.
- Selected current research topics, such as Google’s Sponsored Search Auction, the U.S. FCC Spectrum Auction, Kidney Exchange.

Prerequisites / notice

Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic. Several copies of both books are available in the Computer Science library.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

263-2800-00L Design of Parallel and High-Performance Computing
Advanced topics in parallel / concurrent programming.
Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.

Objective

Literature

No lecture notes.

Content

The main topics of the lecture are:
- alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks
- finite automata, regular and context-free grammars
- Turing machines and computability
- complexity theory and NP-completeness
- design of algorithms for hard problems

The lectures are covered in detail by the textbook “Theoretical Computer Science”.

Basic literature:

Further reading:

More exercises and examples in:
6. A. Asteroth, Ch. Baier: Theoretische Informatik

Prerequisites / notice

During the semester, two non-obligatory test exams will be offered.
Abstract

Instruction sets, storage hierarchies, runtime structures with an emphasis on computers as engines for the execution of compiled programs. Interaction between system software and the hardware. Problems that arise from the final representation, performance measurement and tuning, and program portability issues are covered.

Objective

The objective is to allow students to understand all aspects of the execution of compiled (C) programs on modern architectures -- the instruction set, the storage resources (registers, stack, memory), input/output, the impact of compiler decisions, and the interaction between the operating system and hardware. Two main themes are correctness issues (esp. those that arise from the finite representation of data) and performance issues (incl. measurement and tuning issues). The interface to the operating system is discussed to prepare for subsequent classes on more advanced systems topics.

The two key goals are:

1) To equip students with a thorough understanding of how to write correct programs that run fast on modern computer, and
2) How to write correct and efficient low-level systems code.

Content

This course provides an overview of "computers" as a platform for the execution of (compiled) computer programs. This course provides a programmer's view of how computer systems execute programs, store information, and communicate. The course introduces the major computer architecture structures that have direct influence on the execution of programs (processors with registers, caches, other levels of the memory hierarchy, supervisor/kernel mode, and I/O structures) and covers implementation and representation issues only to the extent that they are necessary to understand the structure and operation of a computer system.

The course attempts to expose students to the practical issues that affect performance, portability, security, robustness, and extensibility. This course provides a foundation for subsequent courses on operating systems, networks, compilers and many other courses that require an understanding of the system-level issues. Topics covered include: machine-level code and its generation by optimizing compilers, address translation, input and output, trap/event handlers, performance evaluation and optimization (with a focus on the practical aspects of data collection and analysis).

Literature

The course is based in part on "Computer Systems: A Programmer's Perspective" (2nd Edition) by R. Bryant and D. O'Hallaron, with some additional material.

Prerequisites / notice

252-0024-00L Parallel Programming,
252-0014-00L Digital Circuits

252-0026-00L Algorithms and Data Structures

Abstract

This course is about fundamental algorithm design paradigms, classic algorithmic problems, and data structures. The connection between algorithms and data structures is explained for geometric and graph problems. For this purpose, fundamental graph theoretic concepts are introduced.

Objective

An understanding of the design and analysis of fundamental algorithms and data structures.

Content


Literature


Part 2

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>252-0209-00L</td>
<td>Algorithms, Probability, and Computing</td>
<td>W</td>
<td>8</td>
<td>4V+2U+1A</td>
<td>E. Welzl, M. Ghaffari, A. Steger, P. Widmayer</td>
</tr>
</tbody>
</table>

Abstract

Advanced design and analysis methods for algorithms and data structures: Randomized Search Trees, Point Location, Minimum Cut, Linear Programming, Randomized Algebraic Algorithms (matchings), Probabilistically Checkable Proofs (introduction).

Objective

Studying and understanding of fundamental advanced concepts in algorithms, data structures and complexity theory.

Lecture notes

Will be handed out.

Literature


Computer Science as Second Subject

Important: You can only enrol in the courses of subject didactics and professional training as a subsidiary subject if you have not more than 12 CP left for additional requirements.

Subject Didactics in Computer Science

<table>
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<tr>
<th>Number</th>
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<tr>
<td>272-0101-00L</td>
<td>Subject Didactics of Computer Science I</td>
<td>O</td>
<td>4</td>
<td>3G</td>
</tr>
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</table>

Simultaneous enrolment in Introductory Practical in
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird

4A

The objective is for the students:

4A

The general objective of the course consists in highlighting the tight connection between the mathematical and algorithmic way of thinking and the approaches adopted by engineering disciplines, and in reflecting on teaching approaches for sustainable computer science teaching activities.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

The Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

The Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

272-0203-00L

2 credits

J. Hromkovic, G. Serafini

272-0204-00L

2 credits

J. Hromkovic, G. Serafini

Mentored Work Subject Didactics Computer Science 272-0203-00L

Mentored Work Subject Didactics Computer Science 272-0204-00L

Mentored Work Subject Didactics in Computer Science for Teaching Diploma and for students upgrading TC to Teaching Diploma Computer Science as Minor Subject

Mentored Work Subject Didactics in Computer Science for Teaching Diploma and for students upgrading TC to Teaching Diploma Computer Science as Minor Subject
Objective
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
Thematische Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

Literature
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Professional Training in Computer Science

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>271-0102-00L</td>
<td>Teaching Internship Including Examination Lessons in Computer Science</td>
<td>O</td>
<td>4</td>
<td>9P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

Abstract
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils’ work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content

Lecture notes
Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Literature
Wird von der Praktikumslehrperson bestimmt.

Computer Science Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

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<th>Key for Hours</th>
<th>Description</th>
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<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</table>

ECTS
European Credit Transfer and Accumulation System

Key for Special Students and Auditors
Special students and auditors need special permission from the lecturers.
Focus Courses

Focus Courses in Computational Science

Focus Core Courses Computational Science

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>263-0006-00L</td>
<td>Algorithms Lab</td>
<td>O</td>
<td>6</td>
<td>4P+1A</td>
<td>A. Steger, E. Welzl, P. Widmayer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Students learn how to solve algorithmic problems given by a textual description (understanding problem setting, finding appropriate modeling, choosing suitable algorithms, and implementing them). Knowledge of basic algorithms and data structures is assumed; more advanced material and usage of standard libraries for combinatorial algorithms are introduced in tutorials.</td>
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<tr>
<td>Objective</td>
<td>The objective of this course is to learn how to solve algorithmic problems given by a textual description. This includes appropriate problem modeling, choice of suitable (combinatorial) algorithms, and implementing them (using C/C++, STL, OGAL, and BGL).</td>
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<tr>
<td>263-0007-00L</td>
<td>Advanced Systems Lab</td>
<td>O</td>
<td>6</td>
<td>4P+1A</td>
<td>G. Alonso</td>
</tr>
<tr>
<td>Abstract</td>
<td>The goal of this course is to teach students how to evaluate the performance of complex computer and software systems. Accordingly, the methodology to carry out experiments and measurements is studied. Furthermore, the modelling of systems with the help of queueing network systems is explained.</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to teach students how to evaluate the performance of complex computer and software systems.</td>
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Focus Core Courses in Computational Science

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>8</td>
<td>3V+2U+2A</td>
<td>J. M. Buhmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.</td>
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<tr>
<td>Objective</td>
<td>Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.</td>
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<tr>
<td>Content</td>
<td>The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.</td>
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<tr>
<td>636-0007-00L</td>
<td>Computational Systems Biology</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>J. Stelling</td>
</tr>
<tr>
<td>Abstract</td>
<td>Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).</td>
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<tr>
<td>Objective</td>
<td>The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.</td>
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<tr>
<td>Content</td>
<td>Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label &quot;Systems Biology&quot;, focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks. We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.</td>
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Data: 06.11.2018 12:57
Autumn Semester 2016
Focus Elective Courses Computational Science

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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>This course covers some of the fundamental</td>
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<td></td>
<td>concepts of computer graphics, namely</td>
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<td>3D object representations and generation</td>
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<td>of photorealistic images from digital</td>
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<td>representations of 3D scenes.</td>
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<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>At the end of the course the students</td>
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<tr>
<td></td>
<td>will be able to build a rendering system.</td>
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<td>The students will study the basic</td>
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<td>principles of rendering and image</td>
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<td></td>
<td>synthesis. In addition, the course is</td>
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<td>intended to stimulate the students'</td>
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<td>curiosity to explore the field of</td>
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<td>computer graphics in subsequent</td>
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<td>courses or on their own.</td>
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<td>This course covers fundamental concepts</td>
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<td>of modern computer graphics. Students</td>
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<td>will learn about 3D object</td>
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<td>representations and the details of how to</td>
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<td>generate photorealistic images from</td>
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<td>digital representations of 3D scenes.</td>
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<td>Starting with an introduction to 3D shape</td>
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<td>modeling and representation, texture</td>
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<td>mapping and ray-tracing, we will move on</td>
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<td>to acceleration structures, the physics</td>
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<td>of light transport, appearance</td>
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<td>modeling and global illumination</td>
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<td>principles and algorithms. We will end</td>
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<td>with an overview of modern image-based</td>
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<td>image synthesis techniques, covering</td>
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<td>topics such as lightfields and depth-image</td>
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<td>based rendering.</td>
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Lecture notes: no

Prerequisites / notice:
Prerequisites:
Fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, programming skills in C++, Visual Computing course recommended.
The programming assignments will be in C++. This will not be taught in the class.

263-5001-00L Introduction to Finite Elements and Sparse Linear System Solving

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<td></td>
<td>Abstract</td>
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<td></td>
<td>The finite element (FE) method is the</td>
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<td>method of choice for (approximately)</td>
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<td>solving partial differential equations</td>
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<td>on complicated domains. In the first third</td>
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<td>of the lecture, we give an introduction</td>
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<td>to the method. The rest of the lecture</td>
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<td>will be devoted to methods for solving the</td>
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<td>large sparse linear systems of equation</td>
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<td>that a typical for the FE method. We will</td>
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<td></td>
<td>consider direct and iterative methods.</td>
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<td>Objective</td>
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<td>Students will know the most important</td>
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<td>direct and iterative solvers for sparse</td>
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<td>linear systems. They will be able to</td>
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<td>determine which solver to choose in</td>
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<td>particular situations.</td>
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<td>Content</td>
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<td></td>
<td>I. THE FINITE ELEMENT METHOD</td>
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<td>(1) Introduction. model problems.</td>
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<td>(2) 1D problems. Piecewise polynomials in</td>
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<td>(3) 2D problems. Triangulations. Piecewise</td>
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<td>polynomials in 2D.</td>
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<td>(4) Variational formulations. Galerkin</td>
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<td>finite element method.</td>
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<td>(5) Implementation aspects.</td>
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<td>II. DIRECT SOLUTION METHODS</td>
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<td>(6) LU and Cholesky decomposition.</td>
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<td>(7) Sparse matrices.</td>
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<td>(8) Fill-reducing orderings.</td>
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<td>III. ITERATIVE SOLUTION METHODS</td>
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<td>(9) Stationary iterative methods,</td>
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<td>preconditioning.</td>
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<td>(10) Preconditioned conjugate gradient</td>
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<td>method (PCG).</td>
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<td>(11) Incomplete factorization preconditioning.</td>
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<td>(12) Multigrid preconditioning.</td>
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<td>(13) Nonsymmetric problems (GMRES, BiCGstab).</td>
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<td>(14) Indefinite problems (SYMMLQ, MINRES).</td>
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Literature:

Prerequisites / notice:
Prerequisites: Linear Algebra, Analysis, Computational Science.
The exercises are made with Matlab.

636-0017-00L Computational Biology

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<tr>
<th>Number</th>
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<td>Abstract</td>
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<td>The aim of the course is to provide</td>
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<td>up-to-date knowledge on how we can study</td>
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<td>biological processes using genetic</td>
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<td>sequencing data. Computational algorithms</td>
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<td>extracting biological information from</td>
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<td>genetic sequence data are discussed, and</td>
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<td>statistical tools to understand this</td>
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<td>information in detail are introduced.</td>
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Objective
Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:
* stochastic models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics
Attendees will apply these concepts to a number of applications yielding biological insight into:
* epidemiology
* pathogen evolution
* macroevolution of species

Content
The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

Lecture notes
Slides of the lecture will be available online.
https://www.bse.ethz.ch/cevo/education/cb-materials.html

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

151-0104-00L Uncertainty Quantification for Engineering & Life Sciences

Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures such as modeling, parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

Seminar Computational Science

Number Title Type ECTS Hours Lecturers
252-5701-00L Advanced Topics in Computer Graphics and Vision W 2 credits 2S M. Gross, O. Sorkine Hornung

Abstract
This seminar covers advanced topics in computer graphics, such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each time the course is offered, a collection of research papers is selected and each student presents one paper to the class and leads a discussion about the paper and related topics.

Objective
The goal is to get an in-depth understanding of actual problems and research topics in the field of computer graphics as well as improve presentations and critical analysis skills.

Content
This seminar covers advanced topics in computer graphics, including both seminal research papers as well as the latest research results. Each time the course is offered, a collection of research papers are selected covering topics such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each student presents one paper to the class and leads a discussion about the paper and related topics. All students read the papers and participate in the discussion.

Lecture notes
no script

Literature
Individual research papers are selected each term. See http://graphics.ethz.ch/ for the current list.

Prerequisites / notice
The courses "Computer Graphics I and II" (GDV I & II) are recommended, but not mandatory.

Focus Courses in Distributed Systems

Focus Core Courses Distributed Systems

Number Title Type ECTS Hours Lecturers
263-3800-00L Advanced Operating Systems W 6 credits 2V+2U+1A T. Roscoe

Abstract
This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems, with a particular emphasis on the challenges of modern hardware features. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.
The goals of the course are, firstly, to give students a broader perspective on OS design than that provided by knowledge of Unix or Windows, building on the material in a standard undergraduate operating systems class, and secondly, to provide them with practical experience in dealing directly with the concurrency, resource management, and abstraction problems confronting OS designers and implementers.

This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems, with a particular emphasis on the challenges of modern hardware features. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.

The course is based around a milestone-oriented project, where students work in small groups to implement major components of a microkernel-based operating system. The final assessment will be a combination grades awarded for milestones during the course of the project, a final written report on the project, and a set of test cases on the final code.

System Security

Abstract

The first part of the lecture covers individual system aspects starting with tamperproof or tamper-resistant hardware in general over operating system related security mechanisms to application software systems, such as host based intrusion detection systems. In the second part, the focus is on system design and methodologies for building secure systems.

Objective

In this lecture, students learn about the security requirements and capabilities that are expected from modern hardware, operating systems, and other software environments. An overview of available technologies, algorithms and standards is given, with which these requirements can be met.

Content

The first part of the lecture covers individual system's aspects starting with tamperproof or tamper-resistant hardware in general over operating system related security mechanisms to application software systems such as host based intrusion detection systems. The main topics covered are: tamper resistant hardware, CPU support for security, protection mechanisms in the kernel, file system security (permissions / ACLs / network filesystem issues), IPC Security, mechanisms in more modern OS, such as Capabilities and Zones, Libraries and Software tools for security assurance, etc.

Along the lectures, model cases will be elaborated and evaluated in the exercises.

Focus Elective Courses Distributed Systems

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<tr>
<td>252-0437-00L</td>
<td>Distributed Algorithms</td>
<td>W</td>
<td>4</td>
<td>3V</td>
<td>F. Mattern</td>
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<tr>
<td>Abstract</td>
<td>Models of distributed computations, time space diagrams, virtual time, logical clocks and causality, wave algorithms, parallel and distributed graph traversals, consistent snapshot, election and symmetry breaking, distributed termination detection, garbage collection in distributed systems, monitoring distributed systems, global predicates.</td>
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<tr>
<td>Literature</td>
<td>- F. Mattern: Verteilte Algorithmen, Springer-Verlag</td>
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<td>- G. Tel: Topics in Distributed Algorithms, Cambridge University Press</td>
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<td>- G. Tel: Introduction to Distributed Algorithms, Cambridge University Press, 2nd edition</td>
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<td></td>
<td>- N. Lynch: Distributed Algorithms, Morgan Kaufmann Publ</td>
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<thead>
<tr>
<th>Number</th>
<th>Distributed Systems Laboratory</th>
<th>W</th>
<th>10</th>
<th>9P</th>
<th>G. Alonso, F. Mattern, T. Roscoe, R. Wattenhofer</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>In the Master Programme max. 10 credits can be accounted by Labs on top of the Interfocus Courses. These Labs will only count towards the Master Programme. Additional Labs will be listed on the Addendum.</td>
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<td>Objective</td>
<td>Gain hands-on-experience with real products and the latest technology in distributed systems.</td>
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<tr>
<td>Content</td>
<td>This course involves the participation in a substantial development and/or evaluation project involving distributed systems technology. There are projects available in a wide range of areas: from web services to ubiquitous computing including wireless networks, ad-hoc networks, RFID, and distributed applications on smartphones.</td>
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Seminar Distributed Systems

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<tr>
<th>Number</th>
<th>Communication Networks Seminar</th>
<th>W</th>
<th>2</th>
<th>2S</th>
<th>T. Roscoe, A. Singla</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>We will study recent advances in computer networking by reading and presenting research papers from recent iterations of the top conferences in the area, including NSDI, SIGCOMM, and CoNEXT.</td>
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<td>Objective</td>
<td>The objectives are (a) to understand the state-of-the-art in the field; (b) to learn to read, present and critique papers; and (c) to identify opportunities for new research.</td>
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<td>Students are expected to attend the entire seminar, choose a topic for presentation from a given list, and make a presentation on that topic. Students are evaluated on the knowledge gained, the presentation made, and the report they present at the end of the semester.</td>
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<th>Number</th>
<th>Hardware Acceleration for Data Processing</th>
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<th>2S</th>
<th>G. Alonso, T. Hoefler, O. Mutlu</th>
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<tr>
<td>Abstract</td>
<td>The seminar will cover topics related to data processing using new hardware in general and hardware accelerators (GPU, FPGA, specialized processors) in particular.</td>
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</table>
Objective

The seminar will cover topics related to data processing using new hardware in general and hardware accelerators (GPU, FPGA, specialized processors) in particular.

Content

The general application areas are big data and machine learning. The systems covered will include systems from computer architecture, high performance computing, data appliances, and data centers.

Prerequisites / note

Students taking this seminar should have the necessary background in systems and low level programming.

<table>
<thead>
<tr>
<th>227-0559-00L</th>
<th>Seminar in Distributed Computing</th>
<th>W</th>
<th>2 credits</th>
<th>2S</th>
<th>R. Wattenhofer</th>
</tr>
</thead>
</table>

Abstract

In this seminar participating students present and discuss recent research papers in the area of distributed computing. The seminar consists of algorithmic as well as systems papers in distributed computing theory, peer-to-peer computing, ad hoc and sensor networking, or multi-core computing.

Objective

In the last two decades, we have experienced an unprecedented growth in the area of distributed systems and networks; distributed computing now encompasses many of the activities occurring in today's computer and communications world. This course introduces the basics of distributed computing, highlighting common themes and techniques. We study the fundamental issues underlying the design of distributed systems: communication, coordination, synchronization, uncertainty. We explore essential algorithmic ideas and lower bound techniques.

In this seminar, students present the latest work in this domain.

Seminar language: English

Content

Different each year. For details see: www.disco.ethz.ch/courses.html

Lecture notes

Slides of presentations will be made available.

Literature

Papers.

The actual paper selection can be found on www.disco.ethz.ch/courses.html.

Focus Courses in Information Security

Focus Core Courses Information Security

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0463-00L</td>
<td>Security Engineering</td>
<td>W</td>
<td>5</td>
<td>2V+2U</td>
<td>D. Basin</td>
</tr>
</tbody>
</table>

Abstract

Subject of the class are engineering techniques for developing secure systems. We examine concepts, methods and tools, applied within the different activities of the SW development process to improve security of the system. Topics: security requirements&risk analysis, system modeling&model-based development methods, implementation-level security, and evaluation criteria for secure systems

Objective

Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.

Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include

* security requirements & risk analysis,
* system modeling and model-based development methods,
* implementation-level security, and
* evaluation criteria for the development of secure systems
Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software. Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include

* security requirements & risk analysis,
* system modeling and model-based development methods,
* implementation-level security, and
* evaluation criteria for the development of secure systems

Modules taught:

1. Introduction
   - Introduction of Infsec group and speakers
   - Security meets SW engineering: an introduction
   - The activities of SW engineering, and where security fits in
   - Overview of this class
2. Requirements Engineering: Security Requirements and some Analysis
   - overview: functional and non-functional requirements
   - use cases, misuse cases, sequence diagrams
   - safety and security
   - FMEA, FTA, attack trees
3. Modeling in the design activities
   - structure, behavior, and data flow
   - class diagrams, statecharts
4. Model-driven security for access control (design)
   - SecureUML as a language for access control
   - Combining Design Modeling Languages with SecureUML
   - Semantics, i.e., what does it all mean,
   - Generation
   - Examples and experience
5. Model-driven security (Part II)
   - Continuation of above topics
6. Security patterns (design and implementation)
7. Implementation-level security
   - Buffer overflows
   - Input checking
   - Injection attacks
8. Testing
   - overview
   - model-based testing
   - testing security properties
9. Risk analysis and management 1 (project management)
   - "risk": assets, threats, vulnerabilities, risk
   - risk assessment: quantitative and qualitative
   - safeguards
   - generic risk analysis procedure
   - The OCTAVE approach
10. Risk analysis: IT baseline protection
    - Overview
    - Example
11. Evaluation criteria
    - CMM
    - systems security engineering CMM
    - common criteria
12. Guest lecture
    - TBA

Literature
- Further relevant books and journal/conference articles will be announced in the lecture.

Prerequisites / notice
- Prerequisite: Class on Information Security

252-1414-00L System Security W 5 credits 2V+2U S. Capkun, A. Perrig

Abstract
The first part of the lecture covers individual system aspects starting with tamperproof or tamper-resistant hardware in general over operating system related security mechanisms to application software systems, such as host based intrusion detection systems. In the second part, the focus is on security design and methodologies for building secure systems.

Objective
In this lecture, students learn about the security requirements and capabilities that are expected from modern hardware, operating systems, and other software environments. An overview of available technologies, algorithms and standards is given, with which these requirements can be met.
Content
The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems such as host based intrusion detection systems. The main topics covered are: tamper resistant hardware, CPU support for security, protection mechanisms in the kernel, file system security (permissions / ACLs / network filesystem issues), IPC Security, mechanisms in more modern OS, such as Capabilities and Zones, Libraries and Software tools for security assurance, etc.

In the second part, the focus is on system design and methodologies for building secure systems. Topics include: patch management, common software faults (buffer overflows, etc.), writing secure software (design, architecture, QA, testing), compiler-supported security, language-supported security, logging and auditing (BSM audit, dtrace, ...), cryptographic support, and trustworthy computing (TGG, SGX).

Along the lectures, model cases will be elaborated and evaluated in the exercises.

263-4640-00L Network Security W 6 credits 2V+1U+2A A. Perrig, T. P. Dübendorfer, S. Frei
Abstract
This course emphasizes applied aspects of Information Security. The students will study a number of topics in a hands-on fashion and students know fundamental networking and intrusion detection.

Objective
Students are aware of current threats that Internet services and networked devices face and can explain appropriate countermeasures.

Students can identify and assess known vulnerabilities in a software system that is connected to the Internet.

Content
Risk management and the vulnerability lifecycle of software and networked services are discussed. Threats like denial of service, spam, worms, and viruses are studied in-depth. Fundamental security related concepts like identity, availability, authentication and secure channels are introduced. State of the art technologies like secure shell, network and transport layer security, intrusion detection and prevention systems, cross-site scripting, secure implementation techniques and more for securing the Internet and web applications are presented. Several case studies illustrate the dark side of the Internet and explain how to protect against current threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

Prerequisites / notice
Knowledge in computer networking and Internet protocols (e.g. course Communication Networks (D-ITET)) or Operating Systems and Networks (D-INFK).

Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.

>>> Focus Elective Courses Information Security

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>252-0811-00L</td>
<td>Applied Security Laboratory</td>
<td>W</td>
<td>8</td>
<td>7P</td>
<td>D. Basin</td>
</tr>
</tbody>
</table>

Abstract
In the Master Programme max. 10 credits can be accounted by Labs on top of the Interfocus Courses. Additional Labs will be listed on the Addendum.

Objective
The Applied Security Laboratory addresses four major topics: operating system security (hardening, vulnerability scanning, access control, logging), application security with an emphasis on web applications (web server setup, common web exploits, authentication, session handling, code security), computer forensics, and risk analysis and risk management.

Content
This course emphasizes applied aspects of Information Security. The students will study a number of topics in a hands-on fashion and carry out experiments in order to better understand the need for secure implementation and configuration of IT systems and to assess the effectiveness and impact of security measures. This part is based on a book and virtual machines that include example applications, questions, and answers.

The students will also complete an independent project: based on a set of functional requirements, they will design and implement a prototypical IT system. In addition, they will conduct a thorough security analysis and devise appropriate security measures for their systems. Finally, they will carry out a technical and conceptual review of another system. All project work will be performed in teams and must be properly documented.

Lecture notes

Literature
Recommended reading includes:
* Various: OWASP Guide to Building Secure Web Applications, available online
* O'Reilly, Loukides: Unix Power Tools, O'Reilly & Associates.
* Fricht: Essential System Administration, O'Reilly & Associates.
* NSTIC: Risk Management Guide for Information Technology Systems, available online as PDF
* BSI: IT-Grundschutzhandbuch, available online

Prerequisites / notice
* The lab allows flexible working since there are only few mandatory meetings during the semester.
* The lab covers a variety of different techniques. Thus, participating students should have a solid foundation in the following areas: information security, operating system administration (especially Unix/Linux), and networking. Students are also expected to have a basic understanding of HTML, PHP, JavaScript, and MySQL because several examples are implemented in these languages.
* Students must be prepared to spend more than three hours per week to complete the lab assignments and the project. This applies particularly to students who do not meet the recommended requirements given above. Successful participants of the course receive 8 credits as compensation for their effort.

* All participants must sign the lab's charter and usage policy during the introduction lecture.

252-1411-00L Security of Wireless Networks W 5 credits 2V+1U+1A S. Capkun
Abstract
Core Elements: Wireless communication channel, Wireless network architectures and protocols, Attacks on wireless networks, Protection techniques.

Objective
After this course, the students should be able to: describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc/sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 827 of 1571

263-4650-00L Specification and Proof of Probabilistic Programs with W 4 credits 2V+1U A. McIver, C. C. Morgan

Abstract The course will introduce participants to semantic models for probabilistic programs. The semantics will provide the fundamental model for deriving generic properties of probabilistic systems, and as a context for proving soundness and completeness of proof techniques.

Objective Students in this course will learn new ways to specify and reason about quantitative properties of probabilistic programs. Both probabilistic programs' functional behaviour and their information-flow properties are important aspects of modern systems building, complementing existing methods of abstraction, nondeterminism and refinement. This course's objective is to give the students the necessary intellectual skills for rigorous reasoning about building such systems.

Content The first part of the course will concentrate on program-semantic foundations that to support rigorous specification and reasoning about such quantitative programs. The second part of the course will demonstrate how these techniques can be used for analysing both qualitative- and quantitative information flow as they apply to leakage of secure information.

Literature The course will follow the book "Abstraction, Refinement and Proof for Probabilistic Systems". Other material will consist of research papers which will be available in the secured area.

Prerequisites / notice The course is intended for MSc and PhD students.

263-4655-00L Lattice Cryptography W 4 credits 2V+1U V. Lyubashevsky

Abstract The course will introduce lattice-based cryptography, which is one of the main candidates for quantum-resistant cryptography.

Objective The objective of the course is to bring the students up to a level where they should be able to read academic papers on state-of-the-art designs of lattice-based primitives.

Content In this course, we will study lattice-based cryptography. We will cover the basic algorithms associated with integer lattices such as Gram-Schmidt orthogonalization, algorithms for finding short and near lattice vectors, as well as the critical algorithm for sampling lattice points according to a discrete Gaussian distribution. We will then proceed to build up a toolbox of lattice-based cryptographic primitives beginning from collision-resistant hash functions, then moving on to digital signatures, encryption, identity-based encryption, and fully-homomorphic encryption. Particular emphasis will be placed on concrete parameters and practical instantiations. For this purpose, we will also study cryptographic constructions based on the hardness of ideal lattices, which are ideals of polynomial rings.

Prerequisites / notice There are no formal mathematical pre-requisites, but students should have "mathematical maturity", which entails dealing with abstract concepts and being comfortable with doing mathematical proofs. Some previous exposure to linear algebra, abstract algebra, and cryptography would be useful.

Seminar Information Security

Number Title Type ECTS Hours Lecturers

252-4601-00L Current Topics in Information Security W 2 credits 2S D. Basin, S. Capkun, A. Perrig

Abstract The seminar covers various topics in information security: security protocols (models, specification & verification), trust management, access control, non-interference, side-channel attacks, identity-based cryptography, host-based attack detection, anomaly detection in backbone networks, key-management for sensor networks.

Objective The main goals of the seminar are the independent study of scientific literature and assessment of its contributions as well as learning and practicing presentation techniques.

Content The seminar covers various topics in information security, including network security, cryptography and security protocols. The participants are expected to read a scientific paper and present it in a 35-40 min talk. At the beginning of the semester a short introduction to presentation techniques will be given.

Selected Topics
- security protocols: models, specification & verification
- trust management, access control and non-interference
- side-channel attacks
- identity-based cryptography
- host-based attack detection
- anomaly detection in backbone networks
- key-management for sensor networks

Literature The reading list will be published on the course web site.

Focus Courses in Information Systems

Focus Core Courses Information Systems

Number Title Type ECTS Hours Lecturers

252-0463-00L Security Engineering W 5 credits 2V+2U D. Basin

Abstract Subject of the class are engineering techniques for developing secure systems. We examine concepts, methods and tools, applied within the different activities of the SW development process to improve security of the system. Topics: security requirements-& risk analysis, system modeling&model-based development methods, implementation-level security, and evaluation criteria for secure systems.

Objective Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software. Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include
- security requirements & risk analysis,
- system modeling and model-based development methods,
- implementation-level security, and
- evaluation criteria for the development of secure systems
Content

Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.

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   - safety and security
   - FMEA, FTA, attack trees

3. Modeling in the design activities
   - structure, behavior, and data flow
   - class diagrams, statecharts

4. Model-driven security for access control (design)
   - SecureUML as a language for access control
   - Combining Design Modeling Languages with SecureUML
   - Semantics, i.e., what does it all mean,
   - Generation
   - Examples and experience

5. Model-driven security (Part II)
   - Continuation of above topics

6. Security patterns (design and implementation)

7. Implementation-level security
   - Buffer overflows
   - Input checking
   - Injection attacks

8. Testing
   - overview
   - model-based testing
   - testing security properties

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   - "risk": assets, threats, vulnerabilities, risk
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   - safeguards
   - generic risk analysis procedure
   - The OCTAVE approach

10. Risk analysis: IT baseline protection
    - Overview
    - Example

11. Evaluation criteria
    - CMM
    - systems security engineering CMM
    - common criteria

12. Guest lecture
    - TBA

Literature

- Further relevant books and journal/conference articles will be announced in the lecture.

Prerequisites / notice

Prerequisite: Class on Information Security

Prerequisites / notice

252-0535-00L Machine Learning W 8 credits 3V+2U+2A J. M. Buhmann

Abstract

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non-parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature

Prerequisites / notice
The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

Focus Elective Courses Information Systems

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>252-0341-01L</td>
<td>Information Retrieval</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>T. Hofmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation.</td>
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<tr>
<td>Objective</td>
<td>In depth understanding of managing, indexing, and retrieving documents with text, image and XML content. Knowledge about basic search algorithms on the web, benchmarking of search algorithms, and relevance feedback methods.</td>
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<tr>
<td>252-0373-00L</td>
<td>Mobile and Personal Information Systems</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>M. Norrie</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course examines how traditional information system architectures and technologies have been adapted to support various forms of mobile and personal information systems. Topics to be covered include: databases of mobile objects; context-aware services; opportunistic information sharing; ambient information; pervasive display systems.</td>
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<tr>
<td>Objective</td>
<td>Students will be introduced to a variety of novel information services and architectures developed for mobile environments in order to gain insight into the requirements and processes involved in designing and developing such systems and learning to think beyond traditional information systems.</td>
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<tr>
<td>Content</td>
<td>Advances in mobile devices and communication technologies have led to a rapid increase in demands for various forms of mobile information systems where the users, the applications and the databases themselves may be mobile. Based on both lectures and breakout sessions, this course examines the impact of the different forms of mobility and collaboration that systems require nowadays and how these influence the design of systems at the database, the application and the user interface level. For example, traditional data management techniques have to be adapted to meet the requirements of such systems and cope with new connection, access and synchronisation issues. As mobile devices have increasingly become integrated into the users' lives and are expected to support a range of activities in different environments, applications should be context-aware, adapting functionality, information delivery and the user interfaces to the current environment and task. Various forms of software and hardware sensors may be used to determine the current context, raising interesting issues for discussion. Finally, user mobility, and the varying and intermittent connectivity that it implies, gives rise to new forms of dynamic collaboration that require lightweight, but flexible, mechanisms for information synchronization and consistency maintenance. Here, the interplay of mobile, personal and social context will receive special attention.</td>
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<td>263-3010-00L</td>
<td>Big Data</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U+1A</td>
<td>G. Fourny</td>
</tr>
<tr>
<td>Abstract</td>
<td>The key challenge of the information society is to turn data into information, information into knowledge, knowledge into value. This has become increasingly complex. Data comes in larger volumes, diverse shapes, from different sources. Data is more heterogeneous and less structured than forty years ago. Nevertheless, it still needs to be processed fast, with support for complex operations.</td>
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<tr>
<td>Objective</td>
<td>This combination of requirements, together with the technologies that have emerged in order to address them, is typically referred to as &quot;Big Data.&quot; This revolution has led to a completely new way to do business, e.g., develop new products and business models, but also to do science -- which is sometimes referred to as data-driven science or the &quot;fourth paradigm&quot;.</td>
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<tr>
<td>Notice</td>
<td>Unfortunately, the quantity of data produced and available -- now in the Zettabyte range (that's 21 zeros) per year -- keeps growing faster than our ability to process it. Hence, new architectures and approaches for processing it were and are still needed. Harnessing them must involve a deep understanding of data not only in the large, but also in the small.</td>
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<tr>
<td>Notice</td>
<td>The field of databases evolves at a fast pace. In order to be prepared, to the extent possible, to the (r)evolutions that will take place in the next few decades, the emphasis of the lecture will be on the paradigms and core design ideas, while today's technologies will serve as supporting illustrations thereof.</td>
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<tr>
<td>Notice</td>
<td>After visiting this lecture, you should have gained an overview and understanding of the Big Data landscape, which is the basis on which one can make informed decisions, i.e., pick and orchestrate the relevant technologies together for addressing each business use case efficiently and consistently.</td>
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</table>
Content
This course gives an overview of database technologies and of the most important database design principles that lay the foundations of the Big Data universe. The material is organized along three axes: data in the large, data in the small, data in the very small. A broad range of aspects is covered with a focus on how they fit all together in the big picture of the Big Data ecosystem.
- physical storage (HDFS, S3)
- logical storage (key-value stores, document stores, column stores, key-value stores, data warehouses)
- data formats and syntaxes (XML, JSON, CSV, XBRL)
- data shapes and models (tables, trees, graphs, cubes)
- an overview of programming languages with a focus on their type systems (SQL, XQuery, MDX)
- the most important query paradigms (selection, projection, joining, grouping, ordering, windowing)
- paradigms for parallel processing (MapReduce) and technologies (Hadoop, Spark)
- optimization techniques (functional and declarative paradigms, query plans, rewrites, indexing)
- applications.

We will also host two guest lectures to get insights from the industry: UBS and Google.

Literature
Papers from scientific journals and proceedings. References will be given as part of the course material during the semester.

263-3210-00L Deep Learning
Number of participants limited to 120.

Abstract
Deep learning is an area within machine learning that deals with algorithms and models that automatically induce multi-level data representations.

Objective
In recent years, deep learning and deep networks have significantly improved the state-of-the-art in many application domains such as computer vision, speech recognition, and natural language processing. This class will cover the fundamentals of deep learning and provide a rich set of hands-on tasks and practical projects to familiarize students with this emerging technology.

Prerequisites
The participation in the course is subject to the following conditions:
1. The number of participants is limited to 120 students (MSc and PhDs).
2. Students must have completed the exam in Machine Learning (252-0535-00) or have acquired equivalent knowledge.

263-5200-00L Data Mining: Learning from Large Data Sets

Abstract
Many scientific and commercial applications require insights from massive, high-dimensional data sets. This course introduces principal, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course covers theoretical foundations and practical applications.

Objective
Many scientific and commercial applications require us to obtain insights from massive, high-dimensional data sets. In this graduate-level course, we will study principal, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course will both cover theoretical foundations and practical applications.

Content
Topics covered:
- Dealing with large data (Data centers; Map-Reduce/Hadoop; Amazon Mechanical Turk)
- Fast nearest neighbor methods (Shingling, locality sensitive hashing)
- Online learning (Online optimization and regret minimization, online convex programming, applications to large-scale Support Vector Machines)
- Multi-armed bandits (exploration-exploitation tradeoffs, applications to online advertising and relevance feedback)
- Active learning (uncertainty sampling, pool-based methods, label complexity)
- Dimension reduction (random projections, nonlinear methods)
- Data streams (Sketches, coresets, applications to online clustering)
- Recommender systems

Prerequisites
Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.

263-5210-00L Probabilistic Artificial Intelligence

Abstract
This course introduces core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.

Objective
How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit "intelligent" behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. The course is designed for upper-level undergraduate and graduate students.

Content
Topics covered:
- Search (BFS, DFS, A*), constraint satisfaction and optimization
- Tutorial in logic (propositional, first-order)
- Probability
- Bayesian Networks (models, exact and approximate inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
- Probabilistic planning (MDPs, POMDPs)
- Reinforcement learning
- Combining logic and probability

Prerequisites
Solid basic knowledge in statistics, algorithms and programming

Seminar Information Systems

Number Title Type ECTS Hours Lecturers
263-3504-00L Hardware Acceleration for Data Processing W 2 credits 2S G. Alonso, T. Hoefler, O. Mutlu

Objective
The seminar will cover topics related to data processing using new hardware in general and hardware accelerators (GPU, FPGA, specialized processors) in particular.

Content
The seminar will cover topics related to data processing using new hardware in general and hardware accelerators (GPU, FPGA, specialized processors) in particular.

Prerequisites
Students taking this seminar should have the necessary background in systems and low level programming.

252-5051-00L Advanced Topics in Machine Learning W 2 credits 2S J. M. Buhmann, T. Hofmann, A. Krause, G. Rätsch

Autumn Semester 2016

Page 831 of 1571
Abstract
In this seminar, recent papers of the pattern recognition and machine learning literature are presented and discussed. Possible topics cover statistical models in computer vision, graphical models and machine learning.

Objective
The seminar “Advanced Topics in Machine Learning” familiarizes students with recent developments in pattern recognition and machine learning. Original articles have to be presented and critically reviewed. The students will learn how to structure a scientific presentation in English which covers the key ideas of a scientific paper. An important goal of the seminar presentation is to summarize the essential ideas of the paper in sufficient depth while omitting details which are not essential for the understanding of the work. The presentation style will play an important role and should reach the level of professional scientific presentations.

Content
The seminar will cover a number of recent papers which have emerged as important contributions to the pattern recognition and machine learning literature. The topics will vary from year to year but they are centered on methodological issues in machine learning like new learning algorithms, ensemble methods or new statistical models for machine learning applications. Frequently, papers are selected from computer vision or bioinformatics - two fields, which relies more and more on machine learning methodology and statistical models.

Literature
The papers will be presented in the first session of the seminar.

252-3001-00L Advanced Topics in Information Systems 2 credits 2S M. Norrie
Number of participants limited to 16.

252-0237-00L Concepts of Object-Oriented Programming 6 credits 3V+2U P. Müller
Course that focuses on an in-depth understanding of object-oriented programming and compares designs of object-oriented programming languages. Topics include different flavors of type systems, inheritance models, encapsulation in the presence of aliasing, object and class initialization, program correctness, reflection
After this course, students will:
Have a deep understanding of advanced concepts of object-oriented programming and their support through various language features.
Be able to understand language concepts on a semantic level and be able to compare and evaluate language designs.
Be able to learn new languages more rapidly.
Be aware of many subtle problems of object-oriented programming and know how to avoid them.

The main goal of this course is to convey a deep understanding of the key concepts of sequential object-oriented programming and their support in different programming languages. This is achieved by studying how important challenges are addressed through language features and programming idioms. In particular, the course discusses alternative language designs by contrasting solutions in languages such as C++, C#, Eiffel, Java, Python, and Scala. The course also introduces novel ideas from research languages that may influence the design of future mainstream languages.

The topics discussed in the course include among others:
The pros and cons of different flavors of type systems (for instance, static vs. dynamic typing, nominal vs. structural, syntactic vs. behavioral typing)
The key problems of single and multiple inheritance and how different languages address them
Generic type systems, in particular, Java generics, C# generics, and C++ templates
The situations in which object-oriented programming does not provide encapsulation, and how to avoid them
The pitfalls of object initialization, exemplified by a research type system that prevents null pointer dereferencing
How to maintain the consistency of data structures

263-2800-00L Design of Parallel and High-Performance Computing 7 credits 3V+2U+1A T. Hoeffler, M. Püschel
Advanced topics in parallel / concurrent programming.
Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.

252-0286-00L System Construction 4 credits 2V+1U F. O. Friedrich
Main goal is teaching knowledge and skills needed for building custom operating systems and runtime environments. Relevant topics are studied at the example of sufficiently simple systems that have been built at our Institute in the past, ranging from purpose-oriented single processor real-time systems up to generic system kernels on multi-core hardware.
The lecture's main goal is teaching knowledge and skills needed for building custom operating systems and runtime environments. The lecture intends to supplement more abstract views of software construction, and to contribute to a better understanding of "how it really works" behind the scenes.
Content
Case Study 1: Embedded System
- Safety-critical and fault-tolerant monitoring system
- Based on an auto-pilot system for helicopters

Case Study 2: Multi-Processor Operating System
- Universal operating system for symmetric multiprocessors
- Shared memory approach
- Based on Language-/System Codesign (Active Oberon / A2)

Case Study 3: Custom designed Single-Processor System
- RISC Single-processor system designed from scratch
- Hardware on FPGA
- Graphical workstation OS and compiler (Project Oberon)

Case Study 4: Custom-designed Multi-Processor System
- Special purpose heterogeneous system on a chip
- Massively parallel hard- and software architecture based on message passing
  - Focus: dataflow based applications

Lecture notes
Printed lecture notes will be delivered during the lecture. Slides will also be available from the lecture homepage.

Seminar Software Engineering

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>263-2100-00L</td>
<td>Research Topics in Software Engineering</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>P. Müller, M. Püschel</td>
</tr>
</tbody>
</table>

Abstract
This seminar is an opportunity to become familiar with current research in software engineering and more generally with the methods and challenges of scientific research.

Objective
Each student will be asked to study some papers from the recent software engineering literature and review them. This is an exercise in critical review and analysis. Active participation is required (a presentation of a paper as well as participation in discussions).

Content
The aim of this seminar is to introduce students to recent research results in the area of programming languages and software engineering. To accomplish that, students will study and present research papers in the area as well as participate in paper discussions. The papers will span topics in both theory and practice, including papers on program verification, program analysis, testing, programming language design, and development tools. A particular focus will be on domain-specific languages.

The publications to be presented will be announced on the seminar home page at least one week before the first session.

The seminar will meet only when there is a scheduled presentation. Please consult the seminar's home page for information.

Organizational note: the seminar will meet only when there is a scheduled presentation. Please consult the seminar's home page for information.

Seminar on the intersection of machine learning, interactive systems and advanced concepts in programming and programming tools.

The seminar will cover a variety of machine learning models and algorithms (including deep neural networks) and will discuss their applications in a diverse set of domains. Furthermore, the seminar will discuss how domain knowledge is integrated into vanilla ML models.

Seminars often suffer from poor attention retention and low student engagement. This is often due to the format of the seminar where only one student reads papers in-depth and then prepares a long presentation about one or sometimes several papers. There is little reason for the other students to really pay attention or engage in the discussion.

To improve this the seminar will use a case-study format where all students read the same paper each week but fulfill different roles and hence prepare with different viewpoints in mind.

Student roles/instructions
The seminar is organized with each student taking one of the following roles on a rotating basis:

- Conference Reviewer (e.g., reviewer of UIST/ICML/PLDI): Complete a full critical review of the paper. Use the original review from and come to a recommendation whether the paper should be accepted or not.

- Historian: Find out how this paper sits in the context of the related work. Use bibliography tools to find the most influential papers cited by this work and at least one paper influenced by the work (and summarize the two papers).

- PhD student: Propose a follow-up project for your own research based on this paper - importantly the project should be directly inspired by the paper or even use/extend the method proposed.

- Hacker: Implement a (simplified) version of the core aspect of the paper. Prepare a demo for the seminar. In case the complexity is too high perform an in-depth analysis of reproducibility of the paper.

- Detective: Find out background information about the authors. Where did they work when the paper was published; what was their role; who else have they published with; which prior work of the authors may have inspired the current paper? Students may contact the authors (but need to adhere to politeness and courteous manners and stay on topic in their conversations).

- All students (every week): Come up with alternative title; find a missing result that the paper should have included.

Student roles/instructions
Participation will be limited subject to available topics.

Focus Courses in Theoretical Computer Science

Focus Core Courses Theoretical Computer Science

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<tbody>
<tr>
<td>252-0417-00L</td>
<td>Randomized Algorithms and Probabilistic Methods</td>
<td>W</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>A. Steger, E. Welzl</td>
</tr>
</tbody>
</table>

Abstract
Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks

Objective
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.
Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Yes.


Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real-world data.

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

No lecture notes, but slides will be made available on the course webpage.


The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments.

Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.

Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.

The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments.


"Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

Several copies of both books are available in the Computer Science library.

No lecture notes.


"Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

Several copies of both books are available in the Computer Science library.

Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

252-0535-00L  Machine Learning  W  8 credits  3V+2U+2A  J. M. Buhmann

Abstract: Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective: Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real-world data.

Content: The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

No lecture notes, but slides will be made available on the course webpage.


The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments.

Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

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This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:

- Introduction to classic game-theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization.
- Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the 'Price of Anarchy');
- Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium.
- Selected current research topics, such as Google's Sponsored Search Auction, the U.S. FCC Spectrum Auction, Kidney Exchange.

No lecture notes.


"Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

Several copies of both books are available in the Computer Science library.

Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.
The objective of the course is to bring the students up to a level where they should be able to read academic papers on state-of-the-art molecular algorithms. Study and understanding of selected topics of interest in molecular algorithms such as: Computational Power of Molecular Algorithms, Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.

Prerequisites:
The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH. Outlook: In the following spring semester there is a seminar "Geometry: Combinatorics and Algorithms" that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.

Literature:

Prerequisites / notice:
There are no formal mathematical pre-requisites, but students should have "mathematical maturity", which entails dealing with abstract concepts and being comfortable with doing mathematical proofs. Some previous exposure to linear algebra, abstract algebra, and cryptography would be useful.

Seminar Theoretical Computer Science

Number Title Type ECTS Hours Lecturers
252-4202-00L Seminar in Theoretical Computer Science W 2 credits 2S E. Welzl, B. Gärtner, M. Hoffmann, J. Lengler, A. Steger, B. Sudakov
Abstract Presentation of recent publications in theoretical computer science, including results by diploma, masters and doctoral candidates.
Objective The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.

263-4311-00L Seminar on Molecular Algorithms Limited number of participants W 2 credits 2S P. Widmayer
Abstract Develop an understanding of selected topics in the area of molecular algorithms, and the practice of science.
Objective Study and understanding of selected topics of interest in molecular algorithms such as: Computational Power of Molecular Algorithms, Molecular Algorithms for Solving Fundamental Tasks (Majority, Leader Election, Counting), Complexity Lower Bounds, Implementations of Algorithms in DNA.
Content This seminar will familiarize the students with current research on molecular algorithms, with a focus on algorithms executable in DNA. We will have an introductory lecture covering the basics of molecular computational models, and the underlying bio-chemical phenomena. Subsequently, we will read and present selected research papers, focusing on their algorithmic content.
No prior knowledge of biology or chemistry will be required.
Literature Selected research articles.
Prerequisites / notice The course will require a good understanding of Randomized Algorithms. Hence, you must have passed our "Randomized Algorithms" class (or have acquired equivalent knowledge, in exceptional cases). No prior knowledge of biology or chemistry will be assumed. The basics will be presented in an introductory lecture.
At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and

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<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>8</td>
<td>3V+2U+2A</td>
<td>J. M. Buhmann</td>
</tr>
</tbody>
</table>

Abstract: Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective: Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content: The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes: No lecture notes, but slides will be made available on the course webpage.


Prerequisites / notice: The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

263-5902-00L | Computer Vision               | W    | 6    | 3V+1U+1A | L. Van Gool, V. Ferrari, A. Geiger

Abstract: The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

Objective: The objectives of this course are:
1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve those.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

Content: Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

Prerequisites / notice: It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.
The seminar “Advanced Topics in Machine Learning” familiarizes students with recent developments in pattern recognition and machine learning. The course will cover state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course will both cover theoretical foundations and practical applications.

### Objective

- How can we build systems that learn from experience in order to improve their performance?
- We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.
- The course is designed for upper-level undergraduate and graduate students.

### Content

- **Topics covered:**
  - Search (BFS, DFS, A*)
  - Constraint satisfaction and optimization
  - Tutorial in logic (propositional, first-order)
  - Probabilistic Artificial Intelligence (models, exact and approximate inference, learning)
  - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
  - Probabilistic palning (MDPs, POMDPs)
  - Reinforcement learning
  - Combining logic and probability

### Prerequisites

- Solid basic knowledge in statistics, algorithms and programming

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### Seminar: Visual Computing

#### 252-5051-00L Advanced Topics in Machine Learning

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<tr>
<th>Number</th>
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<td>Advanced Topics in Machine Learning</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>J. M. Buhmann, T. Hofmann, A. Krause, G. Rätsch</td>
</tr>
</tbody>
</table>

**Abstract**

In this seminar, recent papers of the pattern recognition and machine learning literature are presented and discussed. Possible topics cover statistical models in computer vision, graphical models and machine learning.

**Objective**

The seminar “Advanced Topics in Machine Learning” familiarizes students with recent developments in pattern recognition and machine learning. Original articles have to be presented and critically reviewed. The students will learn how to structure a scientific presentation in English which covers the key ideas of a scientific paper. An important goal of the seminar presentation is to summarize the essential ideas of the paper in sufficient depth while omitting details which are not essential for the understanding of the work. The presentation style will play an important role and should reach the level of professional scientific presentations.

**Content**

The seminar will cover a number of recent papers which have emerged as important contributions to the pattern recognition and machine learning literature. The topics will vary from year to year but they are centered on methodological issues in machine learning like new learning algorithms, ensemble methods or new statistical models for machine learning applications. Frequently, papers are selected from computer vision or bioinformatics - two fields, which relies more and more on machine learning methodology and statistical models.

**Literature**

The papers will be presented in the first session of the seminar.

#### 252-5701-00L Advanced Topics in Computer Graphics and Vision

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>252-5701-00L</td>
<td>Advanced Topics in Computer Graphics and Vision</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>M. Gross, O. Sorkine Hornung</td>
</tr>
</tbody>
</table>

**Number of participants limited to 24.**

**Abstract**

This seminar covers advanced topics in computer graphics, such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photographic. Each time the course is offered, a collection of research papers is selected and each student presents one paper to the class and leads a discussion about the paper and related topics.

**Objective**

The goal is to get an in-depth understanding of actual problems and research topics in the field of computer graphics as well as improve presentations and critical analysis skills.
This seminar covers advanced topics in computer graphics, including both seminal research papers as well as the latest research results. Each time the course is offered, a collection of research papers is selected covering topics such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each student presents one paper to the class and leads a discussion about the paper and related topics. All students read the papers and participate in the discussion.

**Lecture notes**

No script

**Literature**

Individual research papers are selected each term. See http://graphics.ethz.ch/ for the current list.

**Prerequisites / notice**

Prerequisites:
The courses "Computer Graphics I and II" (GDV I & II) are recommended, but not mandatory.

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### Computer Science Elective Courses

The Elective Computer Science Courses can be selected from all Master level courses offered by D-INFK.

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<tr>
<th>Number</th>
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<tr>
<td>252-0293-00L</td>
<td>Wireless and Mobile Computing for Entertainment Applications</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>S. Mangold</td>
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<tr>
<td>252-3610-00L</td>
<td>Smart Energy</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>F. Mattern, V. Tiefenbeck</td>
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<tr>
<td>263-0600-00L</td>
<td>Research in Computer Science</td>
<td>W</td>
<td>5</td>
<td>11A</td>
<td>Professors</td>
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<tr>
<td>227-0778-00L</td>
<td>Hardware/Software Codesign</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>L. Thiele</td>
</tr>
</tbody>
</table>

**Abstract**

This course gives a detailed overview about the 802 standards and summarizes the state of the art for WLANs, WPANs, and WMANs, including new topics such as mesh networks, cognitive radio, and visible light communications. The course combines lectures with a set of assignments in which students are asked to work with a simple JAVA simulation software.

**Objective**

The objective of the course is to learn about the general principles of wireless communications, including physics, frequency spectrum regulation, and standards. Further, the most up-to-date standards and protocols used for wireless LAN IEEE 802.11, Bluetooth and Wi-Fi, mesh networks, sensor networks, cellular networks, visible light communication, and cognitive radios, are analyzed and evaluated.

Students develop their own add-on mobile computing algorithms to improve the behavior of the systems, using a Java-based event-driven simulator. We also hand out embedded systems that can be used for experiments for optical communication.

**Content**


**Lecture notes**

The script will be made available from the course webpage.

**Literature**

1. The course webpage at http://www.lst.inf.ethz.ch/education/wireless.html
2. The Java 802 protocol emulator "JEmula802".

**Prerequisites / notice**

Students should have interest in wireless communication, and should be familiar with Java programming.

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**Abstract**

The lecture covers the role of ICT for sustainable energy usage. Concepts of the emerging smart grid are outlined and approaches to motivate sustainable consumer choices are explained. The lecture combines technologies from ubiquitous computing and traditional ICT with insights from socio-psychological concepts and illustrates them with examples from actual applications.

**Objective**

Participants become familiar with the challenges related to sustainable energy usage, understand the principles of a smart grid infrastructure and its applications, know the role of ubiquitous computing technologies, can explain the challenges regarding security and privacy, can reflect the basics cues to induce changes in consumer behavior, develop a general understanding of the effects of a smart grid infrastructure on energy efficiency, and know how to apply the learning to related design projects.

**Content**

- Background on energy generation and consumption; characteristics, potential, and limitations of renewable energy sources
- Introduction to energy economics
- Smart grid and smart metering infrastructures, virtual power plants, security challenges
- Demand management and home automation using ubiquitous computing technologies
- Changing consumer behavior with smart ICT
- Benefits challenges of a smart energy system

**Literature**

Will be provided during the course, though a good starting point is "ICT for green: how computers can help us to conserve energy" from Friedemann Mattern, Thosten Staake, and Markus Weiss (available at http://www.vs.inf.ethz.ch/pub/papers/ICT-for-Green.pdf).

**Prerequisites / notice**

The lecture includes interactive exercises, case studies and practical examples.

---

**Abstract**

The lecture includes independent project work under the supervision of a Computer Science Professor. Independent project work under the supervision of a Computer Science Professor.

**Objective**

Independent project work under the supervision of a Computer Science Professor.

**Prerequisites / notice**

Only students who fulfill one of the following requirements are allowed to begin a research project:

- 1 lab (interfocus course) and 1 focus course
- 2 core focus courses
- 2 labs (interfocus courses)

A task description must be submitted to the Student Administration Office at the beginning of the work.

**Abstract**

The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.

**Objective**

The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.

**Content**

The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware-Software Interfaces (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures, System-on-Chip), (c) Application specific instruction sets, code generation and retargetable compilation, (d) Performance analysis and estimation techniques, (e) System design (hardware-software partitioning and design space exploration).

**Lecture notes**

Material for exercises, copies of transparencies.
Literature


Prerequisites / notice

Prerequisites for the course is a basic knowledge in the following areas: computer architecture, digital design, software design, embedded systems.

103-0237-00L GIS III W 5 credits 3G M. Raubal

Abstract

The course deals with advanced topics in GIS: GIS project lifecycle, Managing GIS, Legal issues, GIS assets & constraints; Geospatial Web Services: technical basics, architecture, functions, interoperability, standards, mashups, portals, applications; Geostatistics; Sensor Web Enablement; Human-Computer Interaction; Cognitive Issues in GIS.

Objective

Students will get a detailed overview of advanced GIS topics. They will go through all steps of setting up a Web-GIS application in the labs and perform other practical tasks relating to Sensor Web Enablement, Human-Computer Interaction, Geostatistics, and Web Processing Services.

Lecture notes

Lecture slides will be made available in digital form.

Literature


Elective Courses

Students can individually chose from the entire Master course offerings from ETH Zurich, EPF Lausanne, the University of Zurich and - with the consent of the mentor - from all other Swiss universities.

For further details, refer to Art. 31 of the Regulations 2009 for the Master Program in Computer Science.

Number Title Type ECTS Hours Lecturers
263-2900-00L How To Give Strong Technical Presentations Z 0 credits M. Püschel

Objective

Wherever possible I illustrate by example and present the material in a way to make it immediately applicable. The goal is to provide the knowledge that enables the participants, whether beginner or experienced presenter, to further improve their presentation skills and hence their impact whenever they step in front of an audience.

Content

This course covers all aspects of delivering strong presentations. I explain common mistakes, what works and what does not, and why. Then I discuss structure and content as well as a set of fundamental principles from graphic design that make slides communicate effectively. These principles also apply to the presentation and visualization of data which is covered in some detail. Finally, I give some useful tips on the use of Powerpoint that simplify the creation of strong presentations.

Internship

Only for Computer Science MSc.

Number Title Type ECTS Hours Lecturers
252-0700-00L Internship W 0 credits external organisers

Objective

The internship must be at least 10 weeks long and can be undertaken in a Swiss or a foreign company.

Abstract

An internship provides opportunities to gain experience in an industrial environment and creates a network of contacts.

Prerequisites / notice

To register the internship, please submit a document to the Student Administration Office containing the following information at the latest two weeks after beginning the internship:
- a detailed task description: task, technologies, milestones etc.
- start and end date of the internship
- supervisor: name and academic degree

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-INFK.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Master’s Thesis

Only students who fulfill the following criteria are allowed to begin with their master thesis:
- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract

Independent project work supervised by a Computer Science professor. Duration 6 months.

Objective

Independent project work supervised by a Computer Science professor.

Computer Science Master - Key for Type

O Compulsory E- Recommended, not eligible for credits
W+ Eligible for credits and recommended Z Courses outside the curriculum
W Eligible for credits Dr Suitable for doctorate
## Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

### ECTS
- European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Integrated Building Systems Master

Main Courses

Fundamental Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0010-00L</td>
<td>Chemistry</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>C. Mondelli, A. de Mello</td>
</tr>
<tr>
<td></td>
<td>Abstract: This is a general chemistry course aimed at first year undergraduate students in the Department of Mechanical and Process Engineering (D-MAVT). The aims of the course are as follows: 1) To provide a thorough understanding of the basic principles of chemistry and its application. 2) To develop an understanding of the atomic and molecular nature of matter and of the chemical reactions that describe their transformations. 3) To emphasize areas considered most relevant in an engineering context. Content: Electronic structure of atoms, chemical bonding, molecular shape and bonding theory, gases, thermodynamics, chemical thermodynamics, chemical kinetics, equilibria, solutions and intermolecular forces, redox and electrochemistry. Literature: The course is based on &quot;Chemistry the Central Science&quot; by Brown, LeMay, Bursten, Murphy and Woodward. Pearson, 12th Edition (international edition).</td>
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</tbody>
</table>

| 066-0411-00L | Structural Design I                  | W    | 2    | 2V    | P. Block, J. Schwartz   |
|              | Abstract: The course is an introduction to structural design using graphical methods and structural models, with a focus on a creative approach rather than repetitive calculations. Cable and membrane structures, arch and shell structures and combined arch and cable systems will be used to demonstrate these methods. Objective: The objective is to encourage students to develop an intuitive understanding of the relationship between the shape of a structure, the load it needs to carry and the forces in it. To achieve this, the teaching is based on graphic statics, which allow the visualization of internal and external forces in structural systems, therefore illustrating the relationship between shape (form) and stress (force) in load bearing elements. This understanding is directly applied to the students' design projects, in which issues of statics and design overlap. Content: After a general introduction of basic concepts, structural systems such as cable and arch structures will be analyzed with the help of graphic statics. The students will learn to understand the flow of forces in a structural system in relation to the system's form. They will be able to modify this force flow and give dimension to the structural components. Lecture notes: on eQuilibrium http://www.block.arch.ethz.ch/equilibrium and http://http://www.schwartz.arch.ethz.ch/ Literature: "Faustformel Tragwerksentwurf" (Philippe Block, Christoph Gengangel, Stefan Peters, DVA Deutsche Verlags-Anstalt 2013, ISBN: 978-3-421-03904-0) Weiteres Lernmaterial: "Form and Forces: Designing Efficient, Expressive Structures" (Edward Allen, Waclaw Zalewski, October 2009, ISBN: 978-0-470-17465-4) |

| 151-1633-00L | Energy Conversion                    | W    | 4    | 3G    | H. G. Park              |
|              | Abstract: Fundamentals of Thermal Sciences in association with Energy Conversion Objective: To become acquainted and familiarized with basic principles of fundamental thermal sciences (Thermodynamics, Heat Transfer, etc.) as well as their linkage to energy conversion technologies. Content: Thermodynamics (first and second laws), Heat Transfer (conduction/convection/radiation), Technical Applications Lecture notes: Slides will be distributed by e-mail every week. Literature: 1. Introduction to Thermodynamics and Heat Transfer, 2nd ed. by Cengel, Y. A., McGraw Hill; 2. Fundamentals of Engineering Thermodynamics, 6th ed. by Moran & Shapiro, Wiley |

| 401-0203-00L | Mathematics                          | W    | 4    | 2V+1U | C. Busch                |

| 066-0427-00L | Design and Building Process MBS      | W    | 2    | 2V    | A. Paulus               |
|              | Abstract: "Design and Building Process MBS" is a brief manual for prospective architects and engineers covering the competencies and the responsibilities of all involved parties through the design and building process. Lectures on twelve compact aspects gaining importance in a increasingly specialised, complex and international surrounding. Objective: Participants will come to understand how they can best navigate the design and building process, especially in relation to understanding their profession, gaining a thorough knowledge of rules and regulations, as well as understanding how involved parties' minds work. They will also have the opportunity to investigate ways in which they can relate to, understand, and best respond to their clients' wants and needs. Finally, course participants will come to appreciate the various tools and instruments, which are available to them when implementing their projects. The course will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship. |

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Content

“Design and Building Process MBS” is a brief manual for prospective architects and engineers covering the competencies and the responsibilities of involved parties through the design and building process. Twelve compact aspects regarding the establishment building culture are gaining importance in an increasingly specialised, complex and international surrounding. Lectures on the topics of profession, service model, organisation, project, design quality, coordination, costing, tendering and construction management, contracts and agreements, life cycle, real estate market, and getting started will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship. The course introduces the key figures, depicts the criteria of the project and highlights the provided services of the consultants. In addition to discussing the basics, the terminologies and the tendencies, the lecture units will refer to the studies as well as the practice: Teaching-based case studies will complement and deepen the understanding of the twelve selected aspects. The course is presented as a moderated seminar to allow students the opportunity for individual input: active collaboration between the students and their tutor therefore required.

Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>066-0413-00L</td>
<td>Materials and Constructions</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>M. Koebel</td>
</tr>
<tr>
<td>Abstract</td>
<td>Sustainable building construction, high performance materials for energy efficient buildings, focus on next generation building materials, sustainable construction, glazing, energy integration, production processes</td>
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<tr>
<td>Objective</td>
<td>The students will acquire knowledge in the following fields: - Fundamentals of heat transport in (porous) materials - Super-insulating materials and systems (including insulating nano-materials) - Materials for retrofitting of buildings - Introduction to durability problems of building facades - Glazing, windows and glazed facades - Materials for photovoltaic devices and solar thermal collector technology and their integration into buildings - Materials for energy storage (thermal, electrical) and for decentralized energy generation - Embodied energy of building materials. Introduction to LCA analysis for building materials - Integrated building envelope solutions, multi-functional and adaptive facades, smart façade concepts</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Sustainable building construction, high performance materials for energy efficient buildings, focus on next generation building materials, sustainable construction, glazing, energy integration, production processes</td>
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<td></td>
</tr>
<tr>
<td>Literature</td>
<td>J. Carmeliet, D. Derome</td>
<td></td>
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</tbody>
</table>

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>066-0415-00L</td>
<td>Building Physics: Theory and Applications</td>
<td>O</td>
<td>4</td>
<td>3V+1U</td>
<td>J. Carmeliet, J. Allegrini, D. Derome</td>
</tr>
<tr>
<td>Abstract</td>
<td>Principles of heat and mass transport, hygro-thermal performance, durability of the building envelope and interaction with indoor and outdoor climates, applications.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Objective</td>
<td>The students will acquire in the following fields: - Principles of heat and mass transport and its mathematical description. - Indoor and outdoor climate and driving forces. - Hydrothermal properties of building materials. - Building envelope solutions and their construction. - Hydrothermal performance and durability.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Principles of heat and mass transport, hygro-thermal performance, durability of the building envelope and interaction with indoor and outdoor climates, applications.</td>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0193-00L</td>
<td>Renewable Energy Technologies I</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>A. Wokaun, A. Steinfeld</td>
</tr>
<tr>
<td>Literature</td>
<td>Lecture notes will be distributed electronically during the course.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0389-00L</td>
<td>Technology and Innovation Management</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>S. Brusoni</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course focuses on the analysis of innovation as a pervasive process that cut across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.</td>
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<tr>
<td>Objective</td>
<td>This course intends to enable all students to: - understand the core concepts necessary to analyze how innovation happens - master the most common methods and tools organizations deploy to innovate - develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation</td>
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</tr>
<tr>
<td>Literature</td>
<td>Lecture notes will be distributed electronically during the course.</td>
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</tbody>
</table>

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This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success are small.

How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.

Lecture notes
Slides will be available on the TIMGROUP website.

Literature
Readings will be available on the TIMGROUP website.

Prerequisites / notice
No specific background in economics or management is required.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0503-00L</td>
<td>Principles of Microeconomics</td>
<td>3</td>
<td>O</td>
<td>M. Filippini</td>
</tr>
<tr>
<td>066-0423-00L</td>
<td>Application of CFD in Buildings</td>
<td>3</td>
<td>O</td>
<td>D. Lakehal</td>
</tr>
</tbody>
</table>

Abstract
The course introduces basic principles, problems and approaches of microeconomics.

Objective
The learning objectives of the course are:
1. Students must be able to discuss basic principles, problems and approaches in microeconomics.
2. Students can analyse and explain simple economic principles in a market using supply and demand graphs.
3. Students can contrast different market structures and describe firm and consumer behaviour.
4. Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole.
5. Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.

Lecture notes
Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature
N. Gregory Mankiw and Mark P. Taylor (2014), "Economics", 3rd edition, South-Western Cengage Learning. The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:

Complementary:

Abstract
Fundamentals, Applications and Project works in the area of CFD in buildings.

Objective
Understanding:
- Basic principles of fluid flow & heat transfer
- Basic concepts of CFD
- Validation and verification, practical guidelines

Application and project works of CFD in buildings including the fields of:
- Building aerodynamics
- Steady vs. unsteady wind loads on urban structures
- Air pollution and contaminant dispersion
- Indoor ventilation
- CFD for renewable energy in the urban physics: Wind loads on roof-mounted solar photovoltaic arrays, coupled solar-wind energy generation applications, etc.

 Contents
I. Fundamentals
- Basic principles of fluid flow & heat transfer
- Laminar versus turbulent flow
- Forced vs. natural convection
- Basic concepts of CFD (Discretization, schemes, etc.)
- Turbulence modelling
- Near-wall treatment
- Validation and verification, practical guidelines

II. Applications
CFD for:
- Building aerodynamics
- Steady vs. unsteady wind loads on urban structures
- Air pollution and contaminant dispersion
- Indoor ventilation
- CFD for renewable energy in the urban physics: Wind loads on roof-mounted solar photovoltaic arrays, coupled solar-wind energy generation applications, etc.

III. Project work
- Geometry and grid generation (from CAD to domain meshing)
- Exp. wind engineering
- Boundary conditions, solver settings and solution
- Data Post-processing
- Validation and error estimation
- Hands-on-Training
- Presentation

Lecture notes
Material will be sent to the students before the start of the course.

Literature
We will update the material in due time.
Content
- Climate Change. The Global Picture: global energy balance, global climate models, the IPCC process. Towards regional climate scenarios: role of spatial resolution, overview of approaches, hydrostatic RCMs, cloud-resolving RCMs
- Urban micro climate and comfort: urban heat island effect, wind flow and radiation in the built environment, convective heat transport modelling, heat balance and ventilation of urban spaces - impact of morphology, outdoor wind comfort, outdoor thermal comfort,
- Urban energy and urban design. Energy performance of building quarters and cities, decentralized urban energy production and storage technologies, district heating networks, optimization of energy consumption at district level, effect of the micro climate, urban heat islands, and climate change on the energy performance of buildings and building blocks.
- Wind driving rain (WDR): WDR phenomena, WDR experimental and modeling, wind blocking effect, applications and moisture durability
- Pollutant dispersion, pollutant cycle: emission, transport and deposition, air quality
- Urban acoustics, noise propagation through the urban environment, meteorological effects, urban acoustic modeling, noise reduction measures, urban vegetation

Lecture slides will be made available. Lecture notes will be available for some topics (in English).
All material is provided via the website of the chair (www.carmeliet.arch.ethz.ch/Education/).

Advanced course in radiation heat transfer
Applied Fluid Dynamics
Fundamentals of radiative heat transfer and its applications. Examples are combustion and solar thermal/thermochemical processes, and other applications in the field of energy conversion and material processing.

2V+1U
not available
Type
Lecturers
Applied Fluid Dynamics
Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and

Thermodynamics of Novel Energy Conversion Technologies
In the framework of this course we will look at a current electronic thermal and energy management strategies and novel energy conversion processes. The course will focus on component level fundamentals of these process and system level analysis of interactions among various energy conversion components.

Part 1: Fundamentals:
- Overview of exergy analysis, Single phase liquid cooling and micro-mixing;
- Thermodynamics of multi-component-systems (mixtures) and phase equilibrium;
- Electrochemistry;

Part 2: Applications:
- Basic principles of battery;
- Introduction to fuel cells;
- Reuse of waste heat from supercomputers;
- Hotspot targeted cooling of microprocessors
- Microfluidic fuel cells

Part3: System- level analysis
- Integration of the components into the system: a case study
- Analysis of the coupled operations, identification of critical states
- Support to system-oriented design

The course will be given in English:
1. Mid-term examination: Mid-term exam grade counts as 20% of the final grade.
2. Final exam: Written exam during the regular examination session. It counts as 80% of the final grade.

Lecture notes
Prerequisites / notice
Lecture slides will be made available. Lecture notes will be available for some topics (in English).

The course notes will be available via the website of the chair (www.carmeliet.arch.ethz.ch/Education/).

Literature

No prior knowledge is required.

Specialised Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0235-00L</td>
<td>Thermodynamics of Novel Energy Conversion Technologies</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>C. S. Sharma, D. Poulilakos, G. Sansavini</td>
</tr>
</tbody>
</table>

Abstract
In the framework of this course we will look at a current electronic thermal and energy management strategies and novel energy conversion processes. The course will focus on component level fundamentals of these process and system level analysis of interactions among various energy conversion components.

Objective
Part 1: Fundamentals:
- Overview of exergy analysis, Single phase liquid cooling and micro-mixing;
- Thermodynamics of multi-component-systems (mixtures) and phase equilibrium;
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Part 2: Applications:
- Basic principles of battery;
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- Microfluidic fuel cells

Part3: System- level analysis
- Integration of the components into the system: a case study
- Analysis of the coupled operations, identification of critical states
- Support to system-oriented design

Content
The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment.
Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).

Objective
Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples.

Content
Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water.
There are many possible forms that the resulting damage may take, including fire and explosion when flammable substances are mixed.
The topics covered include: Emissions of liquids and gases from containers and pipelines, evaporation from pools and vaporization of gases kept under pressure, the spread and dilution of waste gas plumes in the wind, deflagration and detonation of inflammable gases, firesballs in gases held under pressure, pollution and exhaust gases in tunnels (tunnel fires etc.)

Literature
All material is provided via the website of the chair (www.carmeliet.arch.ethz.ch/Education/).

Prerequisites / notice
No prior knowledge is required.

Thermodynamics of Novel Energy Conversion Technologies
The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment.
Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).

Abstract
In the framework of this course we will look at a current electronic thermal and energy management strategies and novel energy conversion processes. The course will focus on component level fundamentals of these process and system level analysis of interactions among various energy conversion components.

Objective
Part 1: Fundamentals:
- Overview of exergy analysis, Single phase liquid cooling and micro-mixing;
- Thermodynamics of multi-component-systems (mixtures) and phase equilibrium;
- Electrochemistry;

Part 2: Applications:
- Basic principles of battery;
- Introduction to fuel cells;
- Reuse of waste heat from supercomputers;
- Hotspot targeted cooling of microprocessors
- Microfluidic fuel cells

Part3: System- level analysis
- Integration of the components into the system: a case study
- Analysis of the coupled operations, identification of critical states
- Support to system-oriented design

Content
The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment.
Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).

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In the framework of this course we will look at a current electronic thermal and energy management strategies and novel energy conversion processes. The course will focus on component level fundamentals of these process and system level analysis of interactions among various energy conversion components.

Objective
Part 1: Fundamentals:
- Overview of exergy analysis, Single phase liquid cooling and micro-mixing;
- Thermodynamics of multi-component-systems (mixtures) and phase equilibrium;
- Electrochemistry;

Part 2: Applications:
- Basic principles of battery;
- Introduction to fuel cells;
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- Hotspot targeted cooling of microprocessors
- Microfluidic fuel cells

Part3: System- level analysis
- Integration of the components into the system: a case study
- Analysis of the coupled operations, identification of critical states
- Support to system-oriented design

Content

Lecture notes
Copy of the slides presented.
An Introduction to Sustainable Development in the Built Environment

101-0577-00L

3 credits

B. T. Adey

W

2G

G. Habert

Abstract

This course provides an introduction to the notion of sustainable development when applied to our built environment. This year the UN Conference in Paris will shape future world objectives to tackle climate change. "Infrastructure Management 2: Evaluation Tools" will be offered from FS17 on with new title 101-0579-00L

Objective

to equip students with tools to be used to evaluate infrastructure and the level of service being provided from infrastructure

Content

Introduction

Levels of service

Reliability of infrastructure

Availability and maintainability of infrastructure

Mechanistic-empirical models

Regression analysis

Event trees

Fault trees

Markov chains

Neural networks

Bayesian networks

Conclusion

Lecture notes

All necessary materials (e.g. transparencies and hand-outs) will be distributed before class.

Literature

Appropriate reading material will be assigned when necessary.
At the end of the semester, the students have an understanding of the term of sustainable development, its history, the current political and scientific discourses and its relevance for our built environment.

In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environmetal aspects.

The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.

Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.

After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.

The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.

The following topics give an overview of the themes that are to be worked on during the lecture.

- Overview on the history and emergence of sustainable development
- Overview on the current understanding and definition of sustainable development
- Knowledge of methods and algorithms commonly used in transport planning
- Understanding of algorithms and their implementations commonly used in transport planning
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Method 4: Construction, Green Design
- Method 5: Construction, Ultra-light materials
- Method 6: Construction, Deconstruction

The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems. The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students develop their own models.

To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

The slides of the lecture are provided electronically.

The course addresses the assessment of corporate sustainability and its links to strategy, technology, and finance. Students learn why sustainability matters for managers and how businesses can act towards it. E-modules allow students to train critical thinking skills. In the 2nd half of the semester, sustainability challenges on water, energy, mobility, and food are explored in group projects.

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The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such planning problems are the estimation of traffic volumes, prediction of estimated utilization of new public transport lines, and evaluation of effects (e.g. change in emissions of a city) triggered by building new infrastructure and changes to operational regulations.

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The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences. From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the group. Presentations from guest speakers from industry and the public sector, and final presentations by the students.

Introduction to Computational Physics (for Civil Engineers)

Abstract
This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell’s equation), Monte Carlo simulations, percolation, phase transitions

Content

Prerequisites / notice
Lecture and exercise lessons in english

Structural Reliability and Risk Analysis

Abstract
Structural reliability aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing and environmental conditions. Risk analysis combines this information with the consequences of failure in view of optimal decision making. The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment.

Objective
The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field.

Content
Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro- codes usually provide a framework that guarantees safety and reliability. However the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented.

Lecture notes
The course also includes a tutorial using the UQLab software dedicated to real world structural reliability analysis.

Literature
Slides of the lectures are available online every week. A printed version of the full set of slides is proposed to the students at the beginning of the semester.


S. Marelli, R. Schöbi, B. Sudret, UQLab user manual - Structural reliability (rare events estimation), Report UQLab-v0.92-107.

Basic course on probability theory and statistics

Carbon Mitigation

Abstract
Future climate change can only kept within reasonable bounds when CO2 emissions are drastically reduced. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.

Objective
The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.

Content
From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group.

Information Architecture and Future Cities: Smart Cities

Abstract
What are SMART CITIES and how do they emerge? What is the role of architects and urban designers in this process? How do data turn into information as a building material for the future city? The course covers concepts, methods and techniques in design, simulation and communication of cities. The goal is to learn principles and preconditions for the design of sustainable and smart cities.
Objective

Students gain insight into the next generation of design processes for architects and urban designers, and into concepts of the Information Architecture of SMART CITIES, including the influence of Big Data. They learn about the expanded roles of information and of architecture: information and simulation in architecture as means to make the invisible visible, and architecture as a metaphor and ordering system to structure the immense amounts of data of the Information Society. The seminar is highly interactive and discusses visionary case studies in Europe and Asia and new techniques in Big Data informed smart urban design. Apart from learning about and experiencing Information Architecture and SMART CITIES, the course also introduces research and management skills that will distinguish the future ETH architect. An iBook and the edX Massive Open Online Course (MOOC) Future Cities support the course.

Content

SMART CITIES - What will happen when cities change from static configurations into responsive and dynamic structures? What does it mean for buildings that undergo the same changes? What is the impact on architectural and urban design education? How can citizens influence this development? The SMART CITIES course will answer these questions and supply you with the necessary skills and knowledge to understand and design such dynamic structures. The intelligent use of data and information are at the core of this course. Data and information are new building materials of future cities. Citizens produce increasing amounts of data in their daily life, with stationary sensors and mobile smartphones. Using these data, citizens begin to influence the design of future cities and the re-design of existing ones. The course will be a first step towards the emerging citizen design science and cognitive design computing. Those will be the next generation of participatory design and design computing.

Lecture notes

iBook INFORMATION CITIES

Literature

The necessary texts will be found on the Chair's website at: http://www.ia.arch.ethz.ch. We specifically recommend the consultation of the Future Cities Website at: http://www.futurecities.ethz.ch during the entire course. The iBook INFORMATION CITIES is available in the iBooks Store for free.

Prerequisites / notice

Interactive seminar including 3 exercises

Project courses

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<td>066-0425-00L</td>
<td>Integrated Design MBS</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>A. Schlüter</td>
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<td>066-0431-00L</td>
<td>Semester Project MBS</td>
<td>O</td>
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Semester Project

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<th>Number</th>
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<td>066-0431-00L</td>
<td>Semester Project MBS</td>
<td>O</td>
<td>6</td>
<td>13A</td>
<td>Lecturers</td>
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</table>

Abstract

The semester project focuses in solving specific research questions in the field of integrated building systems.
Objective

The semester project is designed to train students in solving specific research questions in the field of integrated building systems. The goal is to apply acquired knowledge which is gained throughout the first year of the master's program. The semester project is advised by a professor who is affiliated with one of the partner departments of the Master program "Integrated building systems".

Content

The semester project is designed to train students in solving specific research questions in the field of integrated building systems. The goal is to apply acquired knowledge which is gained throughout the first year of the master's program. The semester project is advised by a professor who is affiliated with one of the partner departments of the Master program "Integrated building systems".

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-ARCH.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Master's Thesis

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<th>Number</th>
<th>Title</th>
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<td>O</td>
<td>30 credits</td>
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</table>

Abstract

A 6-months Master thesis completes the Master's program of Integrated Building Systems. With the thesis project students are expected to demonstrate their ability to independent and structured scientific thinking.

Objective

A 6-months Master thesis completes the Master's program of Integrated Building Systems. With the thesis project students are expected to demonstrate their ability to independent and structured scientific thinking.

Content

A 6-months Master thesis completes the Master's program of Integrated Building Systems. With the thesis project students are expected to demonstrate their ability to independent and structured scientific thinking. The thesis can be performed either at ETH Zurich, an industrial enterprise, or in a research institution, but has to be advised by one or more professors affiliated with the Master program "Integrated building systems". The responsible supervisor defines the topic in consultation with the student, together with the scope of work, criteria of assessment, and dates of beginning and delivery of the work.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>151-1633-AAL</td>
<td>Energy Conversion</td>
<td>E</td>
<td>4 credits</td>
<td>9R</td>
<td>H. G. Park</td>
</tr>
</tbody>
</table>

Abstract

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Objective

Fundamentals of Thermal Sciences in association with Energy Conversion

Content

Thermodynamics (first and second laws), Heat Transfer (conduction/convection/radiation), Technical Applications

Lecture notes

Slides will be distributed by e-mail every week.

Literature

1. Introduction to Thermodynamics and Heat Transfer, 2nd ed. by Cengel, Y. A., McGraw Hill;
2. Fundamentals of Engineering Thermodynamics, 6th ed. by Moran & Shapiro, Wiley

Prerequisites / notice

This course is intended for students outside of D-MAVT.

101-0414-AAL Transport Planning (Transportation I)

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract

The lecture course discusses the basic concepts, approaches and methods of transport planning in both their theoretical and practical contexts.

Objective

The course introduces the basic theories and methods of transport planning.

Content

Basic theoretical links between transport, space and economic development; basic terminology; measurement and observation of travel behaviour; methods of the four stage approach; cost-benefit analysis.

Literature


Integrated Building Systems Master - Key for Type

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<thead>
<tr>
<th></th>
<th>Compulsory</th>
<th>Recommended, not eligible for credits</th>
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<tr>
<td>O</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Interdisciplinary Sciences Bachelor
► Physical-Chemical Direction
►► 1. Semester (Physical-Chemical Direction)
►►► Compulsory Subjects First Year Examinations

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<tr>
<td>401-1261-07L</td>
<td>Analysis I</td>
<td>O</td>
<td>10 credits</td>
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<td>M. Einsiedler</td>
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<td>Abstract</td>
<td>Introduction to the differential and integral calculus in one real variable: fundamentals of mathematical thinking, numbers, sequences, basic point set topology, continuity, differentiable functions, ordinary differential equations, Riemann integration.</td>
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<td>Objective</td>
<td>The ability to work with the basics of calculus in a mathematically rigorous way.</td>
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<tr>
<td>Literature</td>
<td>K. Koenigsberger: Analysis I, Springer-Verlag</td>
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<td><a href="http://link.springer.com/book/10.1007/978-3-642-18490-1">http://link.springer.com/book/10.1007/978-3-642-18490-1</a></td>
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<td></td>
<td>R. Courant: Vorlesungen über Differential- und Integralechnung, Springer Verlag</td>
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<td></td>
<td>V. Zorich: Analysis I, Springer Verlag 2006</td>
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<td></td>
<td>Chr. Blatter: Analysis, <a href="https://people.math.ethz.ch/%7eblatter/">https://people.math.ethz.ch/%7eblatter/</a></td>
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<td></td>
<td>H. Hauser: Lehrbuch der Analysis. Teubner Verlag</td>
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<td></td>
<td>W. Walter: Analysis I, Springer Verlag</td>
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<td></td>
<td>O. Forster: Analysis I, Vieweg Verlag</td>
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<td></td>
<td>J. Appell: Analysis in Beispielen und Gegenbeispielen. Springer Verlag</td>
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<td></td>
<td>Schichl u. Steinbauer, Einführung in das mathematische Arbeiten</td>
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<td></td>
<td>Beutelspacher, Das ist o.B.d.A. trivial</td>
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<tr>
<td>401-1151-00L</td>
<td>Linear Algebra I</td>
<td>O</td>
<td>7 credits</td>
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<td>- Mastering basic concepts of Linear Algebra</td>
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<td>- Introduction to mathematical methods</td>
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<td>Content</td>
<td>- Basics</td>
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<td></td>
<td>- Vectorspaces and linear maps</td>
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<td></td>
<td>- Systems of linear equations and matrices</td>
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<td>- Determinants</td>
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<td></td>
<td>- Endomorphisms and eigenvalues</td>
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<tr>
<td>402-1701-00L</td>
<td>Physics I</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>A. Wallraff</td>
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<tr>
<td>Abstract</td>
<td>This course gives a first introduction to Physics. The emphasis is on classical mechanics, together with an introduction to thermodynamics.</td>
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<tr>
<td>Objective</td>
<td>Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics.</td>
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<tr>
<td>Literature</td>
<td>See homepage of the lecture.</td>
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<tr>
<td>529-0011-01L</td>
<td>General Chemistry (Physical Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>F. Merkt</td>
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<tr>
<td>Abstract</td>
<td>Atomic structure and structure of matter; Atomic orbitals and energy levels; Quantum mechanical atomic model; Chemical bonding; Equations of state.</td>
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<tr>
<td>Objective</td>
<td>Introduction to Physical Chemistry</td>
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<tr>
<td>Content</td>
<td>Atomic structure and structure of matter: atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic orbitals and energy levels: ionisation energies, atomic spectroscopy, term values and symbols. Quantum mechanical atomic model: wave-particle duality, the uncertainty principle, Schrödinger’s equation, the hydrogen atom, construction of the periodic table of the elements. Chemical bonding: ionic bonding, covalent bonding, molecular orbitals. Equations of state: ideal gases</td>
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<tr>
<td>Lecture notes</td>
<td>See homepage of the lecture.</td>
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<tr>
<td>Literature</td>
<td>See homepage of the lecture.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Voraussetzungen: Maturastoff. Insbesondere Integral- und Differentialechnung.</td>
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►►► Additional First Year Compulsory Subjects

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0011-04L</td>
<td>Practical Course General Chemistry</td>
<td>O</td>
<td>8 credits</td>
<td>12P</td>
<td>H. V. Schönberg, E. C. Meister</td>
</tr>
<tr>
<td>Latest online enrolment is 19.09.2016.</td>
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<tr>
<td>Information about the practical course will be given on the first day.</td>
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</table>
Abstract
Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox reactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration) analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)

Objective
Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kiefer determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements, metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration) analysis of measured values (measuring error, average value, error analysis), states of aggregation (vapour pressure), characteristics of electrolytes (conductivity measurements), thermodynamics (calorimetry)

Content
The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

Lecture notes
http://www.gruetzmacher.ethz.ch/education/labcourses

Prerequisites / notice
Compulsory: online enrolment latest one week prior from the start of the semester

Eletives

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>529-0011-02L</td>
<td>General Chemistry (Inorganic Chemistry) I</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>A. Togni</td>
</tr>
<tr>
<td>529-0011-03L</td>
<td>General Chemistry (Organic Chemistry) I</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>H. Wennemers</td>
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</tbody>
</table>

Prerequisites / literature

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0422-00L</td>
<td>Physical Chemistry II: Introduction to Chemical Reaction Kinetics</td>
<td>O</td>
<td>4 credits</td>
<td>3V+1U</td>
<td>H. J. Wörner</td>
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</table>

Compulsory Subjects Examination Block

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>402-2883-00L</td>
<td>Physics III</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>J. Home</td>
</tr>
</tbody>
</table>

Abstract
Introductory course on quantum and atomic physics, including optics and statistical physics.

Objective
A basic introduction to quantum and atomic physics, including basics of optics and equilibrium statistical physics. The course will focus on the relation of these topics to experimental methods and observations.
Content
Evidence for Quantum Mechanics: atoms, photons, photo-electric effect, Rutherford scattering, Compton scattering, de-Broglie waves.

Quantum mechanics: wavefunctions, operators, Schrödinger's equation, infinite and finite square well potentials, harmonic oscillator, hydrogen atoms, spin.

Atomic structure: Perturbation to basic structure, including Zeeman effect, spin-orbit coupling, many-electron atoms. X-ray spectra, optical selection rules, emission and absorption of radiation, including lasers.

Optics: Fermat's principle, lenses, imaging systems, diffraction, interference, relation between geometrical and wave descriptions, interferometers, spectrometers.

Statistical mechanics: probability distributions, micro and macrostates, Boltzmann distribution, ensembles, equipartition theorem, blackbody spectrum, including Planck distribution.

Lecture notes
Lecture notes will be provided electronically during the course.

Literature


Statistical mechanics: "Statistical Physics", F. Mandl 0-471-91532-7

Electives
For the Bachelor in Interdisciplinary Sciences students can in principle choose from all subjects taught at the Bachelor level at ETH Zurich.

At the beginning of the 2. year an individual study program is established for every student in discussion with the Director of Studies in interdisciplinary sciences. For details see Programme Regulations 2010.

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>252-0027-00L</td>
<td>Introduction to Programming</td>
<td>W</td>
<td>7</td>
<td>4V+2U</td>
<td>T. Gross</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to fundamental concepts of modern programming and operational skills for developing high-quality programs, including large programs as in industry. The course introduces software engineering principles with an object-oriented approach based.</td>
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<tr>
<td>Objective</td>
<td>Many people can write programs. The &quot;Introduction to Programming&quot; course goes beyond that basic goal: it teaches the fundamental concepts and skills necessary to perform programming at a professional level. As a result of successfully completing the course, students master the fundamental control structures, data structures, reasoning patterns and programming language mechanisms characterizing modern programming, as well as the fundamental rules of producing high-quality software. They have the necessary programming background for later courses introducing programming skills in specialized application areas.</td>
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<tr>
<td>Content</td>
<td>Basics of object-oriented programming. Objects and classes, Pre- and postconditions, class invariants, Design by Contract. Fundamental control structures, Assignment and References. Basic hardware concepts. Fundamental data structures and algorithms. Recursion. Inheritance and interfaces, introduction to event-driven design and concurrent programming. Basic concepts of Software Engineering such as the software process, specification and documentation, reuse and quality assurance.</td>
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<tr>
<td>Lecture notes</td>
<td>The lecture slides are available for download on the course page.</td>
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<tr>
<td>Literature</td>
<td>See the course page for up-to-date information.</td>
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<tr>
<td>Prerequisites</td>
<td>There are no special prerequisites. Students are expected to enroll in the other courses offered to first-year students of computer science.</td>
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<tbody>
<tr>
<td>252-0847-00L</td>
<td>Computer Science</td>
<td>W</td>
<td>5</td>
<td>2V+2U</td>
<td>B. Gärtner</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is an algorithmically oriented introduction to programming.</td>
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<tr>
<td>Content</td>
<td>This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes in English and Handouts in German will be distributed electronically along the course.</td>
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<tr>
<td>327-0103-00L</td>
<td>Introduction to Materials Science</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>M. Niederberger, N. Spencer, P. Uggowitzer</td>
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<tr>
<td>Abstract</td>
<td>Fundamental knowledge and understanding of the atomistic and macroscopic concepts of material science.</td>
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<tr>
<td>Objective</td>
<td>Basic concepts in materials science.</td>
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<tr>
<td>Content</td>
<td>Contents:</td>
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<tr>
<td></td>
<td>Atomic structure</td>
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<td></td>
<td>Atomic bonds</td>
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<tr>
<td></td>
<td>Crystalline structure, perfection - imperfection</td>
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<td>Diffusion</td>
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<td>Mechanical and thermal properties</td>
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<td></td>
<td>Phase diagrams</td>
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<td>Kinetics</td>
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<td>Structural materials</td>
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<td></td>
<td>Electric, magnetic and optical properties of materials</td>
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<td></td>
<td>Materials selection criteria</td>
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<tr>
<td>Lecture notes</td>
<td><a href="http://www.multimat.mat.ethz.ch/education/lectures/intro.html">http://www.multimat.mat.ethz.ch/education/lectures/intro.html</a></td>
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<tr>
<td>Literature</td>
<td>James F. Shackelford</td>
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<tr>
<td></td>
<td>Introduction to Materials Science for Engineers</td>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>327-0301-00L</td>
<td>Materials Science I</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>J. F. Löfler, A. R. Studart, P. Uggowitzer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic concepts of metal physics, ceramics, polymers and their technology.</td>
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</table>
The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other more specialized lectures. The central topics are: solids and their lattice structures; interatomic bindings; lattice dynamics, electronic properties of insulators, metals, semiconductors, transport properties, magnetism, superconductivity.

Introduction to Solid State Physics.

The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other more specialized lectures. The central topics are: solids and their lattice structures; interatomic bindings; lattice dynamics, thermal properties of insulators; metals (classical and quantum mechanical description of electronic states, thermal and transport properties of metals); semiconductors (bandstructure and n/p-type doping); magnetism, superconductivity.

A Manuscript is distributed.

This introductory course will develop basic concepts in astrophysics as applied to the understanding of the physics of planets, stars, galaxies, and the Universe.

The course provides an overview of fundamental concepts and physical processes in astrophysics with the dual goals of: i) illustrating physical principles through a variety of astrophysical applications; and ii) providing an overview of research topics in astrophysics.

The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, field-effect transistors. The physics of the quantum Hall effect and of common nanostructures based on two-dimensional electron gases will be discussed, i.e., quantum point contacts, Aharonov-Bohm rings and quantum dots.

At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures:

1. The integer quantum Hall effect
2. Conductance quantization in quantum point contacts
3. the Aharonov-Bohm effect
4. Coulomb blockade in quantum dots

1. Introduction and overview
2. Semiconductor crystals: Fabrication and band structures
3. k.p-theory, effective mass
4. Envelope functions and effective mass approximation, heterostructures and band engineering
5. Fabrication of semiconductor nanostructures
6. Elektrostatics and quantum mechanics of semiconductor nanostructures
7. Heterostructures and two-dimensional electron gases
8. Drude Transport
9. Electron transport in quantum point contacts; Landauer-Büttiker description
10. Ballistic transport experiments
11. Interference effects in Aharonov-Bohm rings
12. Electron in a magnetic field, Shubnikov-de Haas effect
13. Integer quantum Hall effect
14. Coulomb blockade and quantum dots

The course is taught in English.

The lecture is suitable for all physics students beyond the bachelor of science degree. Basic knowledge of solid state physics is recommended. Very ambitioned students in the third year may be able to follow. The lecture can be chosen as part of the PhD-program. The course is taught in English.

A conceptual introduction to theoretical physics: Newtonian mechanics, central force problem, oscillations, Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.

The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.
### Analytical Chemistry I

**Abstract**
Introduction into the most important spectroscopical methods and their applications to gain structural information.

**Content**
- Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
- NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
- IR spectroscopy: Revisiting topics like harmonic oscillators, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.
- UV/VIS spectroscopy: Basics, interpretation of electron spectra. Circular dichroism (CD) and optical rotation dispersion (ORD).

**Prerequisites / notice**
Script will be for the production price

**Literature**
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995
- E. Pretsch, P. Bühlmann, C. Affolter, M. Badertscher, Spektroskopische Daten zur Strukturaufklärung organischer Verbindungen. 4. Auflage, Springer, Berlin/Heidelberg, 2001-

**Fundamentals of Biology IA**

**Abstract**
The course provides an introduction to the basics of molecular- and cell biology and genetics.

**Objective**
Introduction to modern biology and to principal biological concepts.

**Content**
- 1. Basic principles of Evolution.
- 2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules
- 3. The cell: structure; membrane structure and function, cell cycle
- 4. Metabolism: Respiration; Photosynthesis; Fermentation
- 5. Inheritance: meiosis and sexual reproduction; Mendelian genetics, chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution

**Prerequisites / notice**
Certain sections of the text-book must be studied by self-instruction.

**Literature**
The text-book "Biology" (Campbell, Reece) (10th edition) is the basis of the course. The structure of the course is largely identical with that of the text-book.

**Inorganic Chemistry I**

**Abstract**
Complexes of the transition metals: structure, bonding, spectroscopic properties, and synthesis.

**Objective**
Introduction to the bonding theory in complexes of the transition metals. Interpretation of structure, bonding, and spectroscopic properties. General synthetic strategies.

**Content**
The chemical bond (overview). Symmetry and group theory. The chemical bond of coordination compounds (Valence Bond Theory, Crystal Field Theory, Molecular Orbital Theory (sigma- and pi-bonding), pi-Accepting ligands (CO, NO, olefins, dioxygen, dihydrogen, phosphines and phosphites). Electronic spectra of coordination compounds (Tanabe-Sugano diagrams). Coordination numbers and isomers in complexes. Dynamic phenomena (stereoenzymatic nonrigidity). Complexes and kinetics.

**Lecture notes**
Can be bought at the HCI-shop

**Organic Chemistry I**

**Abstract**

**Objective**

**Content**

**Lecture notes**

**Literature**


**529-0051-00L Analytical Chemistry I**

**551-0105-00L Fundamentals of Biology IA**

**529-0121-00L Inorganic Chemistry I**

**529-0221-00L Organic Chemistry I**
Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Objective
Acquisition of a basic repertoire of synthetic methods including important reactions of aldehydes, ketones, carboxylic acids and carboxylic acid derivatives, as well as eliminations and fragmentations. Particular emphasis is placed on the understanding of reaction mechanisms and the correlation between structure and reactivity. A deeper understanding of the concepts presented during the lecture is reached by solving the problems handed out each time and discussed one week later in the exercise class.

Content
Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Lecture notes
A pdf file of the printed lecture notes is provided online. Supplementary material may be provided online.

Literature
No set textbooks. Optional literature will be proposed at the beginning of the class and in the lecture notes.

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701-0023-00L  
**Atmosphere**  
W 3 credits 2V  
H. Wernli, E. M. Fischer, T. Peter

**Abstract**
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Objective**
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

**Content**
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Lecture notes**
Written information will be supplied.

**Literature**

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701-0245-00L  
**Introduction to Evolutionary Biology**  
W 2 credits 2V  
G. Velicer, S. Wielgoss

**Abstract**
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.

**Objective**
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.

**Content**
Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.

**Literature**
Textbook: Evolutionary Analysis  
Scott Freeman and Jon Herron  

**Prerequisites / notice**
The exam is based on lecture and textbook.

---

701-0401-00L  
**Hydrosphere**  
W 3 credits 2V  
R. Kipfer, C. Roques

**Abstract**
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

**Objective**
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle.

**Content**
Topics of the course. Physical properties of water (i.e. density and equation of state)  
- global water resources  
- energy (thermal & kinetic), gas exchange  
- mixing and transport processes in open waters  
- vertical stratification, large scale transport  
- turbulence and mixing  
- mixing and exchange processes in rivers  
- groundwater and its dynamics  
- ground water as part of the terrestrial water cycle  
- aquifers and their properties  
- hydrochemistry and tracer  
- ground water use  
Case studies  
- 1. Water as resource, 2. Water and climate

**Lecture notes**
In addition to the suggested literature handouts are distributed.

**Literature**
Suggested literature.  

**Prerequisites / notice**
The case studies and the analysis of the questions and problems are integral part of the course.

---

701-0423-00L  
**Chemistry of Aquatic Systems**  
W 3 credits 2G  
L. Winkel

**Abstract**
This course gives an introduction to chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system, solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid/water interface, applications to lakes, rivers and groundwater.

**Objective**
Understanding of chemical processes in aquatic systems. Quantitative application of chemical equilibrium to processes in natural waters.

**Content**
Introduction to the chemistry of aquatic systems. Regulation of the composition of natural waters by chemical, geochemical and biological processes. Quantitative application of chemical equilibrium to processes in natural waters. The following topics are treated: acid-base reactions, carbonate system; solubility of solid phases and weathering; complexation of metals and metal cycling in natural waters; redox reactions; reactions at the interface solid phase-water; applications to lakes, rivers, groundwater.

**Lecture notes**
Script is distributed.

**Literature**
Teaching of basic knowledge in microbiology.
Lecture notes can be purchased during the first lecture (15.- SFr).

U. Lohmann, S. Schlegel,
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex

2G

Practical Course General Chemistry
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Content
Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Three obligatory exercises, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary: a Matlab introduction is given). Example programs and graphics tools are supplied.

Lecture notes
List of literature is provided.

701-0473-00L
Weather Systems

W 3 credits

2G M. A. Sprenger, C. Grams

Abstract
This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.

Objective
The students are able to
- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena
- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features
- to explain how mountains influence the atmospheric flow on different scales

Content
Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

Lecture notes
Lecture notes and slides

Literature
Lecture notes, Meteorology: An Introductory Survey
John M. Wallace and Peter V. Hobbs, Academic Press

701-0475-00L
Atmospheric Physics

W 3 credits

2G U. Lohmann, A. A. Mensah

Abstract
This course covers the basics of atmospheric physics, which consist of: cloud and precipitation formation, thermodynamics, aerosol physics, radiation as well as the impact of aerosols and clouds on climate and artificial weather modification.

Objective
Students are able to
- to explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.
- to evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.

Content
Moist processes/thermodynamics; aerosol physics; cloud formation; precipitation processes, storms; importance of aerosols and clouds for climate and weather modification, clouds and precipitation

Lecture notes
Powerpoint slides and script will be made available

Literature

Prerequisites / notice
50% of the time we use the concept of "flipped classroom" (en.wikipedia.org/wiki/Flipped_classroom), which we introduce at the beginning.

We offer a lab tour, in which we demonstrate with some instruments how some of the processes, that are discussed in the lectures, are measured.

There is a additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but voluntary.

701-0501-00L
Pedosphere

W 3 credits

2V R. Kretzschmar

Abstract
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Objective
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Content
Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

Lecture notes
Lecture notes can be purchased during the first lecture (15.- SFr)


Prerequisites / notice
Prerequisites: Basic knowledge in chemistry, biology and geology.

752-4001-00L
Microbiology

W 2 credits

2V M. Schuppler, S. Schlegel, J. Vorholt-Zambelli

Abstract
Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.

Objective
Teaching of basic knowledge in microbiology.

Content

Literature
Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms

Lecture notes
Wird von den jeweiligen Dozenten ausgegeben.

List of literature is provided.

Further Laboratory Courses arising upon specific written request by the students and permission by the Director of studies.

529-0011-04L
Practical Course General Chemistry

O 8 credits

12P H. V. Schönberg, E. C. Meister

Latest online enrolment is 19.09.2016.
In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Prerequisites:
- Practical Course General Chemistry (1. Semester, 529-0011-04)
- Practical Course Inorg. and Org. Chemistry I (2. Sem., 529-0230)
- Attendance of Course Inorg. Chemistry 1 (3. Sem., 529-0121)

If necessary, access priority will be settled according to the results of the first-year examinations.

529-0241-00L Advanced Physics Laboratory I W 9 credits 18P C. Grab, T. M. Ihn

Abstract This laboratory course provides basic training of experimental skills. These are experimental design, implementation, measurement, data analysis and interpretation, as well as error analysis. Written manuals for the individual experiments are available.

Content Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox reactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration)

529-0450-00L Semester Project W 18 credits 18A

Abstract In a semester project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic.

Content Students are accustomed to scientific work and they get to know one specific research field.

529-0020-00L Research Project W 20 credits 20A

Abstract In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective Students are accustomed to scientific work and they get to know one specific research field.

529-0400-00L Bachelor’s Thesis O 15 credits 15D

Abstract It completes the Bachelor program and consists of a scientific project carried out independently.

Objective Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

551-0105-00L Fundamentals of Biology IA O 5 credits 5G M. Aebi, E. Hafen

Abstract The course provides an introduction to the basics of molecular- and cell biology and genetics. Introduction to modern biology and to principal biological concepts.
The course is divided into several chapters:
1. Basic principles of Evolution.
2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules
3. The cell: structure; membrane structure and function, cell cycle
4. Metabolism: Respiration; Photosynthesis; Fermentation
5. Inheritance: meiosis and sexual reproduction; Mendelian genetics, chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution

Lecture notes
None.

Literature
The textbook "Biology" (Campbell, Reece) (10th edition) is the basis of the course.

Prerequisites / notice
Certain sections of the text-book must be studied by self-instruction.

401-0271-00L
Mathematical Foundations I: Analysis A

Abstract
Introduction to calculus in one dimension. Building simple models and analysing them mathematically. Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.

Objective
Introduction to calculus in one dimension. Building simple models and analysing them mathematically.

Content
Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.

Literature
G. B. Thomas, M. D. Weir, J. Hass: Analysis 1, Lehr- und Übungsbuch, Pearson-Verlag
D. W. Jordan, P. Smith: Mathematische Methoden für die Praxis, Spektrum Akademischer Verlag
R. Sperb/M. Akveld: Analysis I (vdf)
L. Papula: Mathematik für Ingenieure und Naturwissenschaftler (3 Bände), Vieweg

Further reading suggestions will be indicated during the lecture.
## Additional First Year Compulsory Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0011-03L</td>
<td>General Chemistry (Organic Chemistry)</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>H. Wennemers</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Introduction to Organic Chemistry</td>
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<td></td>
<td>Classical structure theory, stereochemistry, chemical bonds and bonding, symmetry, nomenclature, organic thermochemistry, conformational analysis, basics of chemical reactions</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>Introduction to the structures of organic compounds as well as the structural and energetic basis of organic chemistry.</td>
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<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Introduction to the history of organic chemistry, introduction to nomenclature, learning of classical structures and stereochemistry: isomerism, Fischer projections, CIP rules, point groups, molecular symmetry and chirality, topicality, chemical bonding: Lewis bonding model and resonance theory in organic chemistry, description of linear and cyclic conjugated molecules, aromaticity, Huckel rules, organic thermochemistry, learning of organic chemistry reactions, intermolecular interactions.</td>
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<tr>
<td>Lecture notes</td>
<td>Copies of the course slides as well as other documents will be provided as pdf files via the moodle platform.</td>
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<tr>
<td>529-0011-01L</td>
<td>General Chemistry (Physical Chemistry)</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>F. Merkt</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Atomic structure and structure of matter; Atomic orbitals and energy levels; Quantum mechanical atom model; Chemical bonding; Equations of state.</td>
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<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Introduction to Physical Chemistry</td>
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<tr>
<td></td>
<td>Atomic structure and structure of matter: atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic orbitals and energy levels: ionisation energies, atomic spectroscopy, term values and symbols. Quantum mechanical atom model: wave-particle duality, the uncertainty principle, Schrödinger’s equation, the hydrogen atom, construction of the periodic table of the elements. Chemical bonding: ionic bonding, covalent bonding, molecular orbitals. Equations of state: ideal gases</td>
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<tr>
<td>Lecture notes</td>
<td>See homepage of the lecture.</td>
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<tr>
<td>Literature</td>
<td>See homepage of the lecture.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Voraussetzungen: Maturastoff. Insbesondere Integral- und Differentialrechnung.</td>
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</table>

### 3. Semester (Biochemical-Physical Direction)

#### Compulsory Subjects Examination Block

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0373-00L</td>
<td>Mathematics III: Partial Differential Equations</td>
<td>W</td>
<td>4</td>
<td>2+1U</td>
<td>F. Da Lio</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.</td>
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</tbody>
</table>

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## Examples of partial differential equations
- Classification of PDEs
- Superposition principle

## One-dimensional wave equation
- D'Alembert's formula
- Duhamel's principle

## Fourier series
- Representation of piecewise continuous functions via Fourier series
- Examples and applications

## Separation of variables
- Resolution of wave and heat equation
- Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

## Laplace equation
- Resolution of the Laplace equation on rectangle, disk and annulus
- Poisson formula
- Mean value theorem and maximum principle

## Fourier transform
- Derivation and Definition
- Inverse Fourier transformation and inversion formula
- Interpretation and properties of the Fourier transform
- Resolution of the heat equation

## Laplace transform
- Definition, motivation and properties
- Inverse Laplace transform of rational functions
- Application to ordinary differential equations

Lecture notes
There are available some Lecture Notes in English and also in German of the Professor. These can be found following the links provided under the tab 'Lernmaterialien'.

Literature
2) Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations, Cambridge University Press
3) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (only Chapters 1,2,6,11)

Prerequisites / notice
Prerequisites: Analysis I and II, Fourier series (Komplexe Analysis)

---

## Analysis III

### Content
1.) Klassifizierung von PDE's
- linear, quasinlinear, nicht-linear
- elliptisch, parabolisch, hyperbolisch

2.) Quasilineare PDE
- Methode der Charakteristiken (Beispiele)

3.) Elliptische PDE
- Bsp: Laplace-Gleichung
- Harmonische Funktionen, Maximumsatz, Mittelwertsformel.
- Methode der Variablenseparation

4.) Parabolische PDE
- Bsp: Wärmeleitungsgleichung
- Bsp: Inverse Wärmeleitungsgleichung
- Methode der Variablenseparation

5.) Hyperbolische PDE
- Bsp: Wellengleichung
- Formel von d'Alembert in (1+1)-Dimensionen
- Methode der Variablenseparation

6.) Greensche Funktionen
- Rechnen mit der Dirac-Deltafunktion
- Idee der Greenschen Funktionen (Beispiele)

7.) Ausblick auf numerische Methoden
- 5-Punkt-Diskretisierung des Laplace-Operators (Beispiele)

### Literature

### Prerequisites / notice
Prerequisites: Analysis I and II, Fourier series (Komplexe Analysis)
### 402-1701-00L

**Abstract**
Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

**Objective**
The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.

**Content**
Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids) Periodic Motion and Waves (periodic motion, mechanical waves, acoustics).

**Lecture notes**
The lecture follows the book “Physics” by Paul A. Tipler.

**Literature**
Paul A. Tipler and Gene P. Mosca, Physics (for Scientists and Engineers), W. H. Freeman and Company

**Prerequisites / notice**
Prerequisites: Mathematics I & II

### 529-0422-00L

**Abstract**
This course gives a first introduction to Physics. The emphasis is on classical mechanics, together with an introduction to thermodynamics.

**Objective**
Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems.

**Content**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</tr>
</thead>
<tbody>
<tr>
<td>529-0422-00L</td>
<td>Introduction to Chemical Reaction Kinetics</td>
<td>O</td>
<td>4 credits</td>
<td>3V+1U</td>
<td>H. J. Wörner</td>
</tr>
</tbody>
</table>

**Lecture notes**

**Literature**
- Voraussetzungen:
  - Mathematik I und II
  - Allgemeine Chemie I und II
  - Physikalische Chemie I

### 529-0221-00L

**Abstract**

**Objective**
Introduction to Chemical Reaction Kinetics

**Content**

**Lecture notes**

**Literature**
- Voraussetzungen:
  - Mathematik I und II
  - Allgemeine Chemie I und II
  - Physikalische Chemie I

### Electives

**Im Bachelor-Studiengang interdisziplinäre Naturwissenschaften können die Studierenden prinzipiell alle Lehrveranstaltungen wählen, die in einem Bachelor-Studiengang der ETH angeboten werden.**


**Number**

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>525-0027-00L</td>
<td>Introduction to Programming</td>
<td>W</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>T. Gross</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to fundamental concepts of modern programming and operational skills for developing high-quality programs, including large programs as in industry. The course introduces software engineering principles with an object-oriented approach based.

**Objective**
Many people can write programs. The "Introduction to Programming" course goes beyond that basic goal: it teaches the fundamental concepts and skills necessary to perform programming at a professional level. As a result of successfully completing the course, students master the fundamental control structures, data structures, reasoning patterns and programming language mechanisms characterizing modern programming, as well as the fundamental rules of producing high-quality software. They have the necessary programming background for later courses introducing programming skills in specialized application areas.

**Content**
Basics of object-oriented programming. Objects and classes. Pre- and postconditions, class invariants, Design by Contract. Fundamental control structures. Assignment and References. Basic hardware concepts. Fundamental data structures and algorithms. Recursion. Inheritance and interfaces, introduction to event-driven design and concurrent programming. Basic concepts of Software Engineering such as the software process, specification and documentation, reuse and quality assurance.

**Lecture notes**
The lecture slides are available for download on the course page.

**Literature**
See the course page for up-to-date information.

**Prerequisites / notice**
There are no special prerequisites. Students are expected to enroll in the other courses offered to first-year students of computer science.

**Number**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>525-0847-00L</td>
<td>Computer Science</td>
<td>W</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>B. Gärtner</td>
</tr>
</tbody>
</table>

**Abstract**
This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.

**Objective**
The goal of this lecture is an algorithmically oriented introduction to programming.

**Content**
This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.

**Lecture notes**
Lecture notes in English and Handouts in German will be distributed electronically along with the course.
### Literature


### 401-0373-00L  Mathematics III: Partial Differential Equations  W  4 credits  2V+1U  F. Da Gio

**Abstract**


**Objective**

The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.

**Content**

- Examples of partial differential equations
  - Classification of PDEs
  - Superposition principle
- One-dimensional wave equation
  - D'Alembert's formula
  - Duhamel's principle
- Fourier series
  - Representation of piecewise continuous functions via Fourier series
  - Examples and applications
- Separation of variables
  - Resolution of wave and heat equation
  - Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions
- Laplace equation
  - Resolution of the Laplace equation on rectangle, disk and annulus
  - Poisson formula
  - Mean value theorem and maximum principle
- Fourier transform
  - Derivation and Definition
  - Inverse Fourier transformation and inversion formula
  - Interpretation and properties of the Fourier transform
- Laplace transform
  - Definition, motivation and properties
  - Inverse Laplace transform of rational functions
  - Application to ordinary differential equations

**Lecture notes**

There are available some Lecture Notes in English and also in German of the Professor. These can be found following the links provided under the tab 'Lernmaterialien'.

### Prerequisites / notice

It is required a minimal background of: 1) multivariables functions (Riemann integrals in two or three variables, change of variables in the integrals through the Jacobian, partial derivatives, differentiability, Jacobian) 2) numerical and functional sequences and series, basic knowledge of ordinary differential equations.

### Literature


2) Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations, Cambridge University Press

3) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (only Chapters 1,2,6,11)


### 401-1151-00L  Linear Algebra I  W  7 credits  4V+2U  M. Akveld

**Abstract**


**Objective**

- Mastering basic concepts of Linear Algebra
- Introduction to mathematical methods

**Content**

- Basics
- Vectorspaces and linear maps
- Systems of linear equations and matrices
- Determinants
- Endomorphisms and eigenvalues

**Literature**


### 401-2303-00L  Complex Analysis  W  6 credits  3V+2U  R. Pandharipande

**Abstract**

Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, analytic continuation, special functions, conformal mappings, Riemann mapping theorem.

**Objective**

Working Knowledge with functions of one complex variables; in particular applications of the residue theorem

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<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0103-00L</td>
<td>Fundamentals of Biology II: Cell Biology</td>
<td>5</td>
<td></td>
<td>The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.</td>
</tr>
<tr>
<td>402-0263-00L</td>
<td>Astrophysics I</td>
<td>10</td>
<td></td>
<td>This introductory course will develop basic concepts in astrophysics as applied to the understanding of the physics of planets, stars, galaxies, and the Universe.</td>
</tr>
<tr>
<td>402-2883-00L</td>
<td>Physics III</td>
<td>7</td>
<td></td>
<td>An introductory course on quantum and atomic physics including optics and statistical physics.</td>
</tr>
<tr>
<td>551-1295-00L</td>
<td>Introduction to Bioinformatics: Concepts and Applications</td>
<td>6</td>
<td></td>
<td>Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.</td>
</tr>
</tbody>
</table>
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

### Content

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0051-00L</td>
<td>Analytical Chemistry I</td>
<td>W 3 credits 3G</td>
<td>D. Günther, M.O. Ebert, R. Zenobi</td>
</tr>
<tr>
<td>529-0121-00L</td>
<td>Inorganic Chemistry</td>
<td>W 3 credits 2V+1U</td>
<td>A. Mezzetti</td>
</tr>
<tr>
<td>752-4001-00L</td>
<td>Microbiology</td>
<td>W 2 credits 2V</td>
<td>M. Schuppler, S. Schlegel, J. Vorholt-Zambelli</td>
</tr>
<tr>
<td>701-0243-01L</td>
<td>Biology III: Essentials of Ecology</td>
<td>W 3 credits 2V</td>
<td>S. Güsewell, C. Vorbiger</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-4001-00L</td>
<td>Microbiology</td>
<td>W 2 credits 2V</td>
<td>M. Schuppler, S. Schlegel, J. Vorholt-Zambelli</td>
</tr>
</tbody>
</table>

Data: 06.11.2018 12:57
Autumn Semester 2016
Page 866 of 1571
Content
- Übersicht der aquatischen und terrestrischen Lebensräume mit ihren Bewohnern
- Einfluss von Umweltfaktoren (Temperatur, Strahlung, Wasser, Nährstoffe etc.) auf Organismen; Anpassung an bestimmte Umweltbedingungen
- Populationsdynamik: Ursachen, Beschreibung, Vorhersage und Regulation
- Interaktionen zwischen Arten (Konkurrenz, Konkurrenz, Parasitismus, Nahrungsnetze)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Ökosysteme: Kompartimente, Stoff- und Energieflüsse
- Biodiversität: Variation, Ursachen, Gefährdung und Erhaltung
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution

Lecture notes
Unterlagen, Vorlesungsfolien und relevante Literatur sind in der Lehrdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagnachmittag zur Verfügung.

Literature
Generelle Ökologie:
Aquatische Ökologie:
Lampert & Sommer 1999. Limnökologie. Thieme, 2. Aufl., ca. Fr. 55.-
Böhle 1995. Limmische Systeme. Springer, ca. Fr. 50.-

Naturschutzbiologie:

701-0245-00L Introduction to Evolutionary Biology
W 2 credits 2V G. Velicer, S. Wielgoss

Abstract
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.

Objective
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution.

Content
Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.

Literature
Textbook:
Evolutionary Analysis
Scott Freeman and Jon Herron

Prerequisites / notice
The exam is based on lecture and textbook.

701-0023-00L Atmosphere
W 3 credits 2V H. Wernli, E. M. Fischer, T. Peter

Abstract
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Objective
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

Content
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Lecture notes
Written information will be supplied.

Literature

701-0501-00L Pedosphere
W 3 credits 2V R. Kipfer, C. Roques

Abstract
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Objective
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

Content
Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

Lecture notes
Lecture notes can be purchased during the first lecture (15. - SFr)

Literature
- Bähler 1995. Limmische Systeme. Springer, ca. Fr. 50.-

701-0401-00L Hydrosphere
W 3 credits 2V R. Kipfer, C. Roques

Abstract
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Objective
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.
Content
Topics of the course.
Physical properties of water (i.e. density and equation of state)
- global water resources
Exchange at boundaries
- energy (thermal & kinetic), gas exchange
Mixing and transport processes in open waters
- vertical stratification, large scale transport
- turbulence and mixing
- mixing and exchange processes in rivers
Groundwater and its dynamics
- ground water as part of the terrestrial water cycle
- ground water hydraulics, Darcy’s law
- aquifers and their properties
- hydrochemistry and tracer
- ground water use
Case studies
- 1. Water as resource, 2. Water and climate

Lecture notes
In addition to the suggested literature handouts are distributed.

Literature
Suggested literature.

Prerequisites / notice
The case studies and the analysis of the questions and problems are integral part of the course.

<table>
<thead>
<tr>
<th>701-0255-00L</th>
<th>Biochemistry</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>H.P. Kohler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Students are able to understand</td>
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</tr>
</tbody>
</table>
- the structure and function of biological macromolecules
- the kinetic bases of enzyme reactions
- thermodynamic and mechanistic basics of relevant metabolic processes |
| Content      | Students are able to describe the relevant metabolic reactions in detail |
Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
Structure and function of proteins
Carbohydrates
Lipids an biological membranes
Enzymes and enzyme kinetics
Catalytic strategies
Metabolism: Basic concepts and design. Repetition of basic thermodynamics
Glycolysis, fermentation
The citric acid cycle
Oxidative phosphorylation
Fatty acid metabolism

| Lecture notes | Horton et al. (Pearson) serves as lecture notes. |
| Prerequisites / notice | Basic knowledge in biology and chemistry is a precondition. |

<table>
<thead>
<tr>
<th>701-0423-00L</th>
<th>Chemistry of Aquatic Systems</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>L. Winkel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course gives an introduction to chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system, solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid/water interface, applications to lakes, rivers and groundwater.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Understanding of chemical processes in aquatic systems. Quantitative application of chemical equilibria to processes in natural waters.</td>
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</tr>
<tr>
<td>Content</td>
<td>Evaluation of analytical data from aquatic systems.</td>
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</tbody>
</table>
Introduction to the chemistry of aquatic systems. Regulation of the composition of natural waters by chemical, geochemical and biological processes.
Quantitative application of chemical equilibria to processes in natural waters. The following topics are treated: acid-base reactions, carbonate system; solubility of solid phases and weathering; complexation of metals and metal cycling in natural waters; redox reactions; reactions at the interface solid phase-water; applications to lakes, rivers, groundwater. |

| Lecture notes | Script is distributed. |

<table>
<thead>
<tr>
<th>701-0461-00L</th>
<th>Numerical Methods in Environmental Sciences</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>C. Schär, O. Fuhrer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.</td>
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</tbody>
</table>

Three obligatory exercises, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary: a Matlab introduction is given). Example programs and graphics tools are supplied.

| Lecture notes | Is provided (CHF 10. - per copy). |
| Literature    | List of literature is provided. |

5. Semester (Biochemical-Physical Direction)

Laboratory Courses arising upon specific written request by the students and permission by the Director of studies.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0450-00L</td>
<td>Semester Project</td>
<td>W</td>
<td>18 credits</td>
<td>18A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>
Abstract
In a semester project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic.

Objective
Students are accustomed to scientific work and they get to know one specific research field.

Bachelor's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0400-00L</td>
<td>Bachelor's Thesis</td>
<td>O</td>
<td>15 credits</td>
<td>15D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
It completes the Bachelor program and consists of a scientific project carried out independently.

Objective
Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

Second and Third Year Additional Subjects

For the Bachelor in Interdisciplinary Sciences students can in principle choose from all subjects taught at the Bachelor level at ETH Zurich.

At the beginning of the 2. year an individual study program is established for every student in discussion with the Director of Studies in interdisciplinary sciences. For details see Programme Regulations 2010.

Other Electives ETH

Further combinations of Compulsory elective subjects arising upon specific written request by the students and permission by the Director of studies.

Course Catalogue of ETH

GESS Science in Perspective

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses

ETH/UZH

Recommended GESS Science in Perspective (Type B) for D-CHAB.

Interdisciplinary Sciences Bachelor - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Interdisciplinary Sciences Master

For the Master in Interdisciplinary Sciences students can in principle choose from all subjects taught at the Master level at ETH Zurich.

At the beginning of the Master studies an individual study program is established for every student in discussion with the Director of Studies in interdisciplinary sciences. For details see Programme Regulations 2007.

▶ Majors

The students can choose from all Majors as provided by the following list: http://www.chab.ethz.ch/lehre/in_msc/index_EN

Furthermore it is also possible to create an individual Majors as specified in Art. 19 paragraph 3 of the Programme Regulations.

Selection of courses of ETH, according individual curriculum.

▶ General Courses

Selection of courses of ETH, according individual curriculum.

▶ Proseminars, Laboratory Courses, Research Projects and Sem. Papers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Selection of courses of ETH, according individual curriculum.</td>
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</tbody>
</table>

529-0020-00L Research Project W 20 credits 20A Lecturers

Abstract
In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective
Students are accustomed to scientific work and they get to know one specific research field.

▶ GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-CHAB.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

▶ Master’s Thesis

If more than 20 credits are acquired by the Master Thesis, select a course of the ETH course catalog with similar content to the specific major of your study program. Registration by the study administration (HCI H201).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Selection of courses of ETH, according individual curriculum.</td>
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</table>

529-1000-00L Master’s Thesis O 20 credits 43D Professors

Objective
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a core or optional subject area as chosen by the student.

Duration of the Master's Thesis 4 months.

529-1000-30L Master’s Thesis O 30 credits 64D Professors

Objective
In the Master Thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a core or optional subject area as chosen by the student.

Duration of the Master's Thesis 6 months, possible only with the permission of the director of studies.

Interdisciplinary Sciences Master - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Eligible for credits and recommended</th>
<th>W+</th>
<th>Eligible for credits</th>
<th>W</th>
<th>Compulsory</th>
<th>O</th>
</tr>
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<tbody>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>Key for Hours</td>
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<td>V</td>
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<td>practical/laboratory course</td>
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</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-2001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>W. Uhlig, J. E. E. Buschmann, S. Canonica, P. Funck, E. C. Meister, R. Verel</td>
</tr>
</tbody>
</table>

**Abstract**

General Chemistry I: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium.

**Objective**

Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

**Content**

1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)

**Lecture notes**

Online-Skript mit durchgerechneten Beispielen.

**Literature**

- Brown, LeMay, Bursten CHEMIE (deutsch)
- Housecroft and Constable, CHEMISTRY (englisch)
- Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0251-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6</td>
<td>4V+2U</td>
<td>A. Cannas da Silva</td>
</tr>
</tbody>
</table>

**Abstract**

This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.

**Objective**

Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.

**Content**

1. Single-Variable Calculus:
   - review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.

2. Linear Algebra and Complex Numbers:
   - systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.

3. Ordinary Differential Equations:
   - separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.

**Literature**

- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).

**Prerequisites / notice**

Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.

**Mathe-Lab (Assistance):**

Mondays 12-14, Tuesdays 17-19, Wednesdays 17-19, in Room HG E 41.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0001-00L</td>
<td>General Biology I</td>
<td>O</td>
<td>3</td>
<td>3V</td>
<td>U. Sauer, O. Y. Martin, A. Widmer</td>
</tr>
</tbody>
</table>

**Abstract**

Organismic biology to teach the basic principles of classical and molecular genetics, evolutionary biology and phylogeny.

**Objective**

First in a series of two lectures given over two semesters for students of agricultural and food sciences, as well as of environmental sciences.

The understanding of some basic principles of biology (inheritance, evolution and phylogeny) and an overview of the diversity of life.
THE FORTHCOMING LECTURE PRESENTS AN INTRODUCTION TO ECOSYSTEMS, INCLUDING THE FUNDAMENTAL CONCEPTS AND THEIR APPLICATION AT DIFFERENT LEVELS OF COMPLEXITY IN ECOLOGICAL RESEARCH.


THE STUDENTS SHOULD LEARN ECOLOGICAL CONCEPTS AT THESE DIFFERENT LEVELS IN THE CONTEXT OF CONCRETE EXAMPLES FROM TERRESTRIAL AND AQUATIC ECOSYSTEMS. CORRESPONDING METHODS FOR STUDYING THE SYSTEMS WILL BE PRESENTED.

A FURTHER AIM OF THE LECTURE IS THAT STUDENTS ACHIEVE AN UNDERSTANDING OF BIODIVERSITY, WHY IT IS THREATENED AND HOW IT CAN BE MANAGED.

- Einfluss von Umweltfaktoren (Temperatur, Strahlung, Wasser, Nährstoffe etc.) auf Organismen; Anpassung an bestimmte Umweltbedingungen
- Populationsdynamik: Ursachen, Beschreibung, Vorhersage und Regulation
- Interaktionen zwischen Arten (Konkurrenz, Koeexistenz, Prädation, Parasitismus, Nahrungsnetz)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Ökosysteme: Kompartimente, Stoff- und Energieflusse
- Biodiversität: Variation, Ursachen, Gefährdung und Erhaltung
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution

Lecture notes
Unterlagen, Vorlesungsfolien und relevante Literatur sind in der Lehrdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagmorgen zur Verfügung.

Literature
- Generelle Ökologie:

701-0243-01L Biology III: Essentials of Ecology 3 credits 2V

Abstract
This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in ecological research. Ecological concepts are exemplified by using aquatic and terrestrial systems; correspondingmethodological approaches are demonstrated. In a more applied part of the lecture threats to biodiversity and the appropriate management are discussed.

Objective
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the individual, the population, the community and the ecosystem level.

Content
- Übersicht der aquatischen und terrestrischen Lebensräume mit ihren Bewohnern
- Einfluss von Umweltfaktoren (Temperatur, Strahlung, Wasser, Nährstoffe etc.) auf Organismen; Anpassung an bestimmte Umweltbedingungen
- Populationsdynamik: Ursachen, Beschreibung, Vorhersage und Regulation
- Interaktionen zwischen Arten (Konkurrenz, Koeexistenz, Prädation, Parasitismus, Nahrungsnetz)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Ökosysteme: Kompartimente, Stoff- und Energieflusse
- Biodiversität: Variation, Ursachen, Gefährdung und Erhaltung
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution

Lecture notes
Unterlagen, Vorlesungsfolien und relevante Literatur sind in der Lehrdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagmorgen zur Verfügung.

Literature
- Generelle Ökologie:

701-0013-00L World Food System 4 credits 4V

Abstract
Knowledge about the World Food System will be provided, based on case studies along food chain values in countries with various development stages and dependent on multiple boundary conditions. This shall generate profound understanding of the associated global challenges especially food scarcity, suboptimal diet and nutrition, food quality and safety as well as effects on the environment.

Objective
Attending this course, the students will recognize the elements of the World Food System (WFS) approach and the problems it this supposed to treat. They will especially comprehend the four pillars of global food security, namely (I) food availability (including sustainable production and processing), (II) access to food (physical and monetary), (III) food use (including quality and safety as well as the impact on human health and well being) and (IV) resilience to the boundary conditions (environmental, economic and political). This insight will make them aware of the global driving forces behind our ETH research on food security and is expected to alleviate motivation and understanding for the association of subsequent specific courses within a general context. The course equivalently implements agricultural and food sciences, thus supporting the interdisciplinary view on the WFS scope.

Content
Case studies on certain foods of plant and animal origin serve to demonstrate the entire food value chain from the production of raw material to processed food and its consumer relevant property functions. In doing so, important corresponding aspects for developed, emerging and developing countries are demonstrated, by use of engineering as well as natural and social science approaches.

Lecture notes
Handouts and links are provided online.

Literature
Information on books and other literature references is communicated during the course.

Prerequisites / notice
The course shall particularly elucidate the cross section of Agro- and Food Sciences in the context of important global problems to be solved. Furthermore the students in the first year of studies shall be given some insight and outlook supporting the development of their views and interests in agricultural and food sciences further.

The course is part of the block exam after the first study year. Paper copies can be used (“Open Book”) during the on-line exam, but no other means are not allowed. The course is taught in German.
1. Modeling and simulations

Laboratory Course: Elementary Chemical Techniques
N. Kobert, M. Morbidelli

Prerequisites / notice
electronic platform

529-0030-00L Laboratory Course: Elementary Chemical Techniques O 3 credits 6P N. Kobert, M. Morbidelli, M. H. Schroth, B. Wehrli

Abstract
This practical course provides an introduction to elementary laboratory techniques. The experiments cover a wide range of techniques, including analytical and synthetic techniques (e.g. investigation of soil and water samples or the preparation of simple compounds). Furthermore, the handling of gaseous substances is practised.

Objective
This course is intended to provide an overview of experimental chemical methods. The handling of chemicals and proper laboratory techniques represent the main learning targets. Furthermore, the description and recording of laboratory processes is an essential part of this course.

Content
The classification and analysis of natural and artificial compounds is a key subject of this course. It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks: Selected samples (e.g. soil and water) will be analysed with various methods, such as titrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvation or precipitation processes) is studied. The synthesis of simple inorganic complexes or organic molecules is practised. Furthermore, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.

Lecture notes
The script will be published on the web. Details will be provided on the first day of the semester.

Content
- describe fundamental micro- and macroeconomic issues and theories.
- apply suitable economic arguments to a given theme.
- evaluate economic measures.

Literature


701-0027-00L Environmental Systems I O 2 credits 2V C. Schar, S. Bonhoeffer, N. Dubois

Abstract
The lecture provides a science-based exploration of environmental aspects from three research fields: earth, climate, and health sciences.

Objective
The students are able to explain important properties of the three environmental systems, to discuss critical drivers, trends and conflicts of their use, and to compare potential solutions.

Content
The lecture discusses the role of the environmental systems based on selected environmental problems, among these the exploration of raw materials and fossil fuels, climate change and its impacts on man and environment, and the spread and control of infectious diseases in the human population and agricultural systems.

Lecture notes
Slides are provided by instructors and are accessible via moodle.

751-0801-00L Biology I: Laboratory Exercises O 1 credit 2U E. B. Truernit

Abstract

Objective
Capability of preparing biological specimen, microscopy and documentation. Understanding the correlation between plant structure and function at the level of organs, tissues and cells. Awareness of the link between plant anatomy, systemsatics, physiology, ecology, and development.

Content
- awareness of the size of the microscopic objects. Preparation of specimen for light microscopy. Plant tissue staining techniques. Special features of plant cells. Anatomical adaptations to different environments.

Lecture notes
Handouts

For further reading (not obligatory):
Gerhard Wanner; Mikroskopisch-Botanisches Praktikum, Georg Thieme Verlag, Stuttgart.

Groups of a maximum of 30 students.

Autumn Semester 2016
Literature
A thorough study of all script materials is requested before the course starts.

Electives
A list with possible electives will be published separately.

Bachelor Studies (Programme Regulations 2010)
3. Semester
Basic Courses II
Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>402-0063-00L</td>
<td>Physics II</td>
<td>O</td>
<td>5</td>
<td>3V+1U</td>
<td>A. Vaterlaus</td>
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<tr>
<td>Abstract</td>
<td>Introduction to the &quot;way of thinking&quot; and the methodology in Physics, with the help of demonstration experiments. The Chapters treated are Electromagnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena. Whenever possible, examples relevant to the students' main field of study are given.</td>
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<tr>
<td>Objective</td>
<td>Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.</td>
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<tr>
<td>Content</td>
<td>Elektromagnetismus, Elektromagnetische Wellen, Wellenoptik, Strahlenoptik, Quantenoptik, Quantenmechanik, Thermische Eigenschaften, Transportphänomene, Wärmestrahlung</td>
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<td>Lecture notes</td>
<td>Skript wird verteilt.</td>
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<tr>
<td>Literature</td>
<td>Friedhelm Kuypers</td>
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<tr>
<td></td>
<td>Physik für Ingenieure und Naturwissenschaftler</td>
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<td>Band 2 Elektrizität, Optik, Wellen</td>
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<td>Wiley-VCH, 2012</td>
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<td>ISBN 3527411445, 9783527411443</td>
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<td>Douglas C. Giancoli</td>
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<td>Physik</td>
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<td>3. erweiterte Auflage</td>
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<td>Pearson Studium</td>
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<td>Hans J. Paus</td>
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<td>Physik in Experimenten und Beispielen</td>
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<td>Carl Hanser Verlag, München, 2002, 1068 S.</td>
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<td></td>
<td>Paul A. Tipler</td>
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<td></td>
<td>Spektrum Akademischer Verlag, 1998, 1522 S., ca Fr. 120.-</td>
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<td></td>
<td>David Halliday, Robert Resnick, Jearl Walker</td>
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<td>Physik</td>
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<td>Wiley-VCH, 2003, 1388 S., Fr. 87.- (bis 31.12.03)</td>
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<td>dazu gratis Onlin Ressourcen (z.B. Simulationen): <a href="http://www.halliday.de">www.halliday.de</a></td>
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<tr>
<td>701-0071-00L</td>
<td>Mathematics III: Systems Analysis</td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>N. Gruber, D. Byrne</td>
</tr>
<tr>
<td>Abstract</td>
<td>The objective of the systems analysis course is to deepen and illustrate the mathematical concepts on the basis of a series of very concrete examples. Topics covered include: linear box models with one or several variables, non-linear box models with one or several variables, time-discrete models, and continuous models in time and space.</td>
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<tr>
<td>Objective</td>
<td>Understanding and applying the systems-analytic approach, i.e., Recognizing the core of the problem - simplification - quantitative approach - prediction.</td>
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<tr>
<td>Content</td>
<td><a href="http://www.up.ethz.ch/education/systems-analysis.html">http://www.up.ethz.ch/education/systems-analysis.html</a></td>
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<tr>
<td>Lecture notes</td>
<td>Overhead slides will be made available through Ilias.</td>
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<tr>
<td>752-4001-00L</td>
<td>Microbiology</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>M. Schuppler, S. Schlegel, J. Vorholt-Zambelli</td>
</tr>
<tr>
<td>Abstract</td>
<td>Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.</td>
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<tr>
<td>Objective</td>
<td>Teaching of basic knowledge in microbiology.</td>
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<tr>
<td>Content</td>
<td>Der Schwerpunkt liegt auf den Themen: Bakterielle Zellbiologie, Molekulare Genetik, Wachstumsphysiologie, Biochemische Diversität, Phylogenie und Taxonomie, Prokaryotische Vielfalt, Interaktion zwischen Menschen und Mikroorganismen sowie Biotechnologie.</td>
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<tr>
<td>Lecture notes</td>
<td>Wird von den jeweiligen Dozenten ausgegeben.</td>
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<tr>
<td>Literature</td>
<td>Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms</td>
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<tr>
<td>701-0255-00L</td>
<td>Biochemistry</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>H.P. Kohler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes.</td>
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<tr>
<td>Objective</td>
<td>Students are able to understand - the structure and function of biological macromolecules - the kinetic bases of enzyme reactions - thermodynamic and mechanistic basics of relevant metabolic processes Students are able to describe the relevant metabolic reactions in detail</td>
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</tbody>
</table>
Content

Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
Structure and function of proteins
Carbohydrates
Lipids and biological membranes
Enzymes and enzyme kinetics
Catalytic strategies
Metabolism: Basic concepts and design. Repetition of basic thermodynamics
Glycolysis, fermentation
The citric acid cycle
Oxidative phosphorylation
Fatty acid metabolism

Lecture notes
Horton et al. (Pearson) serves as lecture notes.

Prerequisites / notice
Basic knowledge in biology and chemistry is a precondition.

752-6305-00L

Physiology and Anatomy I

Abstract
Imparts a basic understanding of physiology and anatomy in man, focusing on the interrelations between morphology and function of the human organism. This is fostered by discussing all subjects from a functional point of view. One major topic of the lecture is food intake and digestion with its correlated chemosensory, endocrine and metabolic processes.

Objective
At the end of the course the students understand the basic functions of the organ systems and functionally important morphological features. One focus of the course is on aspects related to nutrition and overweight including the resulting diseases.

Lecture notes
Handouts for each topic will be made available online: http://www.fpb.ethz.ch/de/teaching/handouts.html

701-0225-00L

Organic Chemistry

Abstract
Introduction to Isomerism.
Reaction mechanisms in organic chemistry (substitutions, additions, eliminations condensations)
Biosynthesis of Terpenes.

Objective
The students are able to differentiate between structural and stereoisomers.
The students know the basic reaction mechanisms in organic chemistry. They are able to understand and formulate simple biochemical reactions.
They know the basics of the biosynthesis of terpenes.

Content
Isomerism (structural isomers, stereoisomers).
Descriptive chemistry of natural products (glycerides, peptides, saccharides).
Reaction mechanisms (substitutions, additions, eliminations, condensations).
The citric acid cycle, the gloxylate cycle.
Biosynthesis of terpenes.

Literature
Carsten Schmuck, Basisbuch Organische Chemie, Pearson

Prerequisites / notice
Der Stoff der Basischemie wird vorausgesetzt.

Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>751-1551-00L</td>
<td>Ressourcen- und Umweltökonomie</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>L. Bretschger, A. Müller</td>
</tr>
</tbody>
</table>

Abstract
Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

Objective
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
Introduction to resource and environmental economics
Importance of resource and environmental economics
Main issues of resource and environmental economics
Normative basis
Utilitarianism
Fairness according to Rawls
Economic growth and environment
Externalities in the environmental sphere
Governmental internalisation of externalities
Private internalisation of externalities: the Coase theorem
Free rider problem and public goods
Types of public policy
Efficient level of pollution
Tax vs. permits
Command and Control Instruments
Empirical data on non-renewable natural resources
Optimal price development: the Hotelling-rule
Effects of exploration and Backstop-technology
Effects of different types of markets.
Biological growth function
Optimal depletion of renewable resources
Social inefficiency as result of over-use of open-access resources
Cost-benefit analysis and the environment
Measuring environmental benefit
Measuring costs
Concept of sustainability
Technological feasibility
Conflicts sustainability / optimality
Indicators of sustainability
Problem of climate change
Cost and benefit of climate change
Climate change as international ecological externality
International climate policy: Kyoto protocol
Implementation of the Kyoto protocol in Switzerland
Content
Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes
The script and lecture material are provided at: https://moodle-app2.let.ethz.ch/course/view.php?id=140

Literature

Additional Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>402-0000-02L</td>
<td>Laboratory Course in Physics for Students in Food Sciences</td>
<td>O</td>
<td>2 credits</td>
<td>4P</td>
<td>A. Biland, M. Doebelli, M. Mühlich</td>
</tr>
</tbody>
</table>

Abstract
The central aim is to provide an individual experience of the physical phenomena and the basic principles of the experiment. By conducting simple physical experiments the student will learn how to properly use physical instruments and how to evaluate the results correctly.

Objective
This laboratory course aims to provide basic knowledge of:
- the setup of a physics experiment,
- the use of measurement instruments,
- various measuring techniques,
- the analysis or measurement errors,
- and the interpretation of the measured quantities.

Content
Fehlerrechnung, 9 ausgewählte Versuche zu folgenden Themen:
- Transversalschwingung einer Saite,
- Mechanische Resonanze, Innere Reibung in Flüssigkeiten, Absoluter Nullpunkt der Temperaturskala,
- Universelle Gaskonstante, Spezifische Verdampfungswärme, Spezifische Wärme, Interferenz und Beugung, Drehung der Polarisationssehne,

The Die Auswahl der Versuche kann zwischen den verschiedenen Studiengängen variieren.

Lecture notes
Anleitungen zum Physikalischen Praktikum

752-4003-00L Practical Course in Microbiology

Abstract
Basic principles of the handling of microorganisms (MO) - Detection of MO in the environment - Foodmicrobiology - Morphology and diagnostics of MO - Morphology and physiology of fungi - Antimicrobial agents - Microbial genetics - Bacterial physiology and interactions - Microbial pest control

Objective
The students are familiar with the laboratory work with microorganisms. Specific emphasis is put on the isolation and maintenance of pure cultures and the required hygiene measures. The students know the practical, clinical and ecological importance of microorganisms.

Content
In an introductory part students are made familiar with the handling and cultivation of microorganisms (MO). Afterwards, the students detect MO in the environment and use MO for the conservation of food. This part is then followed by a practical introduction on routine diagnostics of MO and experiments with antimicrobial agents. The part on diagnostics is complemented by an overview over the morphology and physiology of fungi. On simple experiments, the students experience the interaction of MO with higher organisms - the common topic of all research groups at the Institute of Microbiology. Some simple experiments demonstrate the importance of MO in molecular genetics. The course ends with an example of applied microbiology i.e. an experiment on microbial pest control.

Lecture notes
A detailed script of approx. 100 pp. and other relevant documents are available at Moodle at latest 1 week before the beginning of the practical course.

Literature
Recommended literature (facultative):
- Allgemeine Mikrobiologie by Georg Fuchs and Hans G. Schlegel, Thieme-Verlag, 9. Auflage 2014
- Taschenlehrbuch Biologie: Mikrobiologie by Katharina Munk, Thieme Verlag, 2008

Prerequisites / notice
Performance of the students in this practical course is controlled by:
1. Attendance of all 7 course days
2. Giving a short communication to a selected topic of Microbiology (in groups of 3 students)
3. Handing in of written reports to selected experiments (in groups of 2 students)

Participating PhD students who collect credit points during their thesis are examined in a 30-minute oral exam at the end of the course.

Basics of Food Science

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>752-1101-00L</td>
<td>Food Analysis I</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
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</table>

Abstract
The course will be offered again in the spring semester.

Objective
To understand the basic principles of analytical chemistry. To get acquainted with the principles and applications of important routine methods of instrumental food analysis (UV/VIS, IR, AAS, GC, HPLC).

Content

Lecture notes
The lectures are supplemented with handouts.

Literature
a) Georg Schwedt, Analytische Chemie, 2. vollständig überarbeitete Auflage 2008
b) R. Matissek, G. Steiner, M. Fischer, Lebensmittelanalytik, 5. Auflage 2014

752-1000-00L Food Chemistry I

Abstract
To familiarise with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

Objective
To familiarise with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 877 of 1571
The lectures Food Chemistry I and Food Chemistry II constitute a unit.

The lectures are supplemented with handouts.


Elmadfa I & Leitzmann C: Ernährung des Menschen

UTB Ulmer, Stuttgart, 4. überarb. Ausgabe 2004

Garrow JS and James WPT: Human Nutrition and Dietetics
Churchill Livingstone, Edinburgh, 11th rev. ed. 2005

Food Microbiology I
For students of the study programme Biology BSc the course can only be selected as 4th concept course.

This lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and moulds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms. The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.
Content
1. History of Food Microbiology
   1. Short synopsis of foodborne microorganisms
   2. Spoilage of Foods
   3. Foodborne Disease
   4. Food Preservation
   5. VIP's of Food Microbiology
2. Overview of Microorganisms in Foods
   1. Origin of foodborne Microorganisms
   2. Bacteria
   3. Yeasts
   4. Molds
3. Microbial Spoilage of Foods
   1. Intrinsic and Extrinsic Parameters
   2. Meats, Seafoods, Eggs
   3. Milk and Milk Products
   4. Vegetable and Fruit Products
   5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   6. Drinks and Canned Foods
4. Foodborne Disease
   1. Significance and Transmission of Foodborne pathogens
   2. Staphylococcus aureus
   3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4. Listeria monocytogenes
   5. Salmonella, Shigella, Escherichia coli
   6. Vibrio, Yersinia, Campylobacter
   7. Brucella, Mycobacterium
   8. Parasites
   9. Viruses and Bacteriophages
   10. Mycotoxins
   11. Bioactive Amines
   12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

Lecture notes
Electronic copies of the presentation slides (PDF) and additional material will be made available for download.

Literature
Recommendations will be given in the first lecture

>>> Food Science General Courses

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-1101-00L</td>
<td>Finances and Accounting System</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>M. Dumondel</td>
</tr>
<tr>
<td>Abstract</td>
<td>To understand accounting as a component of the complex system of the enterprise</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>To understand accounting not as an isolated discipline, but as a part of the complex system of the enterprise</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Accounting system as a part of management economics. The different steps for scheduling and evaluation of the accountancy will be studied. The main part of the lecture is dedicated to the financial accounting nevertheless the fundamentals of the internal cost-accounting will also be presented. The lecture will also include the clarification of concrete cases and the calculation of practical exercises.</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Course documentation and specified educational books</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>In the lecture one indicates</td>
<td></td>
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</tr>
</tbody>
</table>

| 551-0317-00L | Immunology I                                  | W    | 3 credits | 2V   | A. Oxenius, M. Kopf|
| Abstract     | Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response. |
| Objective    | Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response. |
| Content      | - Introduction and historical background - Innate and adaptive immunity. Cells and organs of the immune system - B cells and antibodies - Generation of diversity - Antigen presentation and Major Histoincompatibility (MHC) antigens - Thymus and T cell selection - Autoimmunity - Cytotoxic T cells and NK cells - Th1 and Th2 cells, regulatory T cells - Allergies - Hypersensitivities - Vaccines, immune-therapeutic interventions |
| Lecture notes| Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"|
| Prerequisites / notice | Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung". |

| 751-1307-00L | Managerial Economics Agri-Food Chain: Strategic Concepts | W    | 2 credits | 2G   | M. Weber, B. Höltisch |
| Abstract     | Learn and exercise strategic concepts in the Agri-Food chain, i.e. theories of economics based decision making combined with entrepreneurial practice. |
| Objective    | The main objectiv is to understand strategic decisions along the value chain in the Agri-Food Chain. |
| Content      | - Basics of strategy & strategic concepts - Classic process of strategy process - Selected alternative processes - Case studies |
| Lecture notes| Dokuments will be distributed per lecture. |
| Literature   | Lombriser Roman & Aplanalp Peter: Strategisches Management |

| 752-2120-00L | Consumer Behaviour I                         | W    | 2 credits | 2V   | M. Siegrist, C. Keller, B. S. Sütterlin |
| Abstract     | Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individudal determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior |

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 879 of 1571
Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior

752-1003-00L Food Chemistry II W+ 3 credits 2V L. Nyström, M. Erzinger

To familiarize with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

To familiarize with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

Descriptive chemistry of food constituents (proteins, lipids, carbohydrates, plant phenolics, flavour compounds). Reactions which affect the colour, flavour, texture, and the nutritional value of raw food products and food products during processing, storage and preparation in a positive or in a negative way (e.g. lipid oxidation, Maillard reaction, enzymatic browning). Links to food analysis, food processing, and nutrition.

The lectures Food Chemistry I and Food Chemistry II constitute a unit.

The lectures are supplemented with handouts.


752-1103-00L Food Analysis II W+ 3 credits 2V T. Gude

To get acquainted with the principles and applications of mass spectrometry in food analytics.

Imparts a basic understanding of physiology and anatomy in man, focusing on the interrelations between morphology and function of the human organism. This is fostered by discussing all subjects from a functional point of view. One major topic of the lecture is food intake and digestion with its correlated chemosensory, endocrine and metabolic processes.

The lectures are supplemented with handouts.


752-3001-00L Food Process Engineering II W+ 3 credits 3G P. Braun

To get acquainted with the principles and applications of mass spectrometry in food analytics.

To get acquainted with the principles and applications of mass spectrometry in food analytics.

Main focus: Mass spectrometry, applications of mass spectrometry (MS).

The lectures are supplemented with handouts.

The lectures are supplemented with handouts.


752-2000-00L Food Materials Science W+ 4 credits 3G R. Mezzenga, G. Nyström

Principles of soft condensed matter applied to food polymers, surfactants and colloids

Understanding the fundamental physical principles ruling the self-assembly, aggregation, processing and structure-properties relationship in food systems constituted by polysaccharides (polymers), proteins (colloids) and lipids (surfactants).

The lectures are supplemented with handouts.


752-6307-00L Physiology and Anatomy III W 3 credits 2V W. Langhans, R. Clara

Imparts a basic understanding of physiology and anatomy in man, focusing on the interrelations between morphology and function of the human organism. This is fostered by discussing all subjects from a functional point of view. One major topic of the lecture is food intake and digestion with its correlated chemosensory, endocrine and metabolic processes.

At the end of the course the students understand the basic functions of the organ systems and functionally important morphological features. One focus of the course is on aspects related to nutrition and overweight including the resulting diseases.

Handouts for each topic will be made available online: http://www.fpb.ethz.ch/de/teaching/handouts.html

Number Title Type ECTS Hours Lecturers
752-4007-00L Experimental Food Microbiology W 3 credits 4P M. Schuppler, M. Loessner

Registration only after having attended the course Lebensmittel-Mikrobiologie I (752-4005-00L).

Teaching of basic experimental knowledge for detection and identification of relevant microorganisms in food. Various practical experiments were accompanied by theoretic introductions to the different topics. The students become acquainted with state-of-the-art methods with main focus on modern molecular techniques for the rapid detection of food borne pathogens.

Teaching of basic experimental knowledge for detection and identification of relevant microorganisms in food.

Grundtechniken für die mikrobiologische Untersuchung von Lebensmitteln, Qualitätssicherung, Anwendung von antimikrobiellen Wirkstoffen, Nachweismethoden für die wichtigsten pathogenen Keime aus Lebensmitteln und einzelnen Keimen aus fermentierten oder probiotischen Lebensmitteln mit klassischen Methoden (u.a. Anreicherungssysteme, ELISA, Enzymsysteme) und Methoden der Molekularbiologie (PCR, Hybridisierung, in situ-Nachweis), Durchführung von Gentransfermethoden mit Mikroorganismen (Konjugation, Transformation) und Bakteriophagen in Lebensmitteln

Wird am Praktikumsanfang abgegeben.

- Krämer: "Lebensmittel-Mikrobiologie" (Ulmer; UTB)
- Süßmuth et al.: " Mikrobiologisch-Biochemisches Praktikum" (Thieme)

Important information!

During the course we will work with the food-borne pathogen Listeria monocytogenes. Listeria monocytogenes represents a particular threat in case of pregnancy. Due to biosafety reasons participation is not allowed in case of pregnancy.

Bachelor’s Thesis

Number Title Type ECTS Hours Lecturers
752-0220-20L Bachelor’s Thesis O 15 credits 32D Lecturers

The Bachelor Thesis completes the Bachelor programme and consists of a scientific project carried out independently under the tutorship of a lecturer at D-HEST.

The Bachelor Thesis aims at fostering the student's ability to independent, structured and scientific working and at deepening their knowledge in a specific field.
### Food Science Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**  European Credit Transfer and Accumulation System  
Special students and auditors need special permission from the lecturers.
## Educational Science

### Introduction to Test Theory and Test Construction in Educational Contexts (University of Zürich)

**Raum**

**ECTS**

**Credits**

**Prerequisites**

**Literature**

**Abstract**

**Objective**

**Content**

**Lecture notes**

**Prerequisites / notice**

**Number**

**Title**

851-0240-00L

Human Learning (EW1)

This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

The course offers an introduction to learning processes and their foundational understandings. The learning process is discussed in the context of psychology, educational sciences, and the humanities. The course covers cognitive, affective, and motivational aspects of learning and their interplay. The role of technology in learning is also addressed. The course is designed for educators, psychologists, researchers, and anyone interested in learning processes.

- The course aims to provide a comprehensive overview of educational psychology and learning theories.
- Participants will learn about the latest research findings in the field of learning and instruction.
- They will develop the ability to critically evaluate learning theories and their applications in the classroom.
- The course will also cover the development and evaluation of educational software and multimedia applications.

The course will cover the following topics:

1. Introduction to learning theories and their historical development.
2. Cognitive psychology: learning styles, information processing, memory, and attention.
3. Affective psychology: motivation, emotions, and attitudes in learning.
5. Technology and learning: digital learning environments, educational technology, and design principles.
6. Assessment and evaluation of learning.

**Note:** This course is offered in the Autumn Semester 2016. Enrolment is limited, and interested students are advised to register early.
Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)."

Abstract
This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective
- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites / notice
Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

851-0242-07L Human Intelligence
Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).
Number of participants limited to 30.
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)."

Abstract
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

Objective
- Understanding of research methods used in the empirical human sciences
- Understanding findings relevant for education

851-0242-08L Research Methods in Educational Science
Number of participants limited to 30.
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)."

Abstract
Literature from the learning sciences is critically discussed with a focus on research methods.
At the first meeting, working groups will be assembled and meetings with those will be set up.
In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objective
- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

851-0240-22L Coping with Psychosocial Demands of Teaching (EW4 DZ)
Number of participants limited to 20.
The successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

Abstract
In this class, students will learn concepts and skills for coping with psychosocial demands of teaching

Objective
Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.
(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

Subject Didactics and Professional Training

Lecture notes
Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Literature
Von der Praktikumslehrperson bestimmt.

### Further Subject Didactics

#### Number
| 752-9005-00L |

#### Title
Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Food Sc.

#### Type
O

#### Credits
2

#### Hours
4A

#### Lecturers
G. Kaufmann, K. Koch, U. Lerch

#### Abstract
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

#### Objective
The aim is for the students to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.

- Independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership.

- To try out different options for specialist further training in their profession.

#### Content
Thematical Schwerpunkte:


Lernformen:


Lecture notes
Eine Anleitung zur mentorierten Arbeit in FV wird zur Verfügung gestellt.

Literature
Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

### Food Science TC - Key for Type

| O  | Compulsory               | E- | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended | Z | Courses outside the curriculum |
| W  | Eligible for credits     | Dr | Suitable for doctorate |

### Key for Hours

| V  | lecture                  | P  | practical/laboratory course |
| G  | lecture with exercise    | A  | independent project |
| U  | exercise                 | D  | diploma thesis |
| S  | seminar                  | R  | revision course / private study |
| K  | colloquium               |    |                            |

### ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Food Science Master

#### Major in Food Processing

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>752-3103-00L</td>
<td>Food Rheology I</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>P. A. Fischer</td>
</tr>
<tr>
<td>752-2003-00L</td>
<td>Selected Topics in Food Technology</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>J. Ubbink</td>
</tr>
<tr>
<td>752-2314-00L</td>
<td>Physics of Food Colloids</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>P. A. Fischer, R. Mezzenga</td>
</tr>
<tr>
<td>752-2314-00L</td>
<td>Food Process Design and Optimization</td>
<td>W+</td>
<td>4 credits</td>
<td>2G</td>
<td>E. J. Windhab</td>
</tr>
</tbody>
</table>

#### Disciplinary Subjects

<table>
<thead>
<tr>
<th>Number</th>
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<td>4 credits</td>
<td>2G</td>
<td>E. J. Windhab</td>
</tr>
</tbody>
</table>

#### Abstract

Rheology is the science of flow and deformation of matter such as polymers, dispersions (emulsions, foams, suspensions), and colloidal systems. The fluid dynamical basis, measuring techniques (rheometry), and the flow properties of different fluids (Newtonian, non-Newtonian, viscoelastic) are discussed.

The course provides an introduction on the link between flow and structural properties of flowing material. Rheometrical techniques and appropriate measuring protocols for the characterization of complex fluids will be discussed. The concept of rheological constitutive equations and the application to different material classes are established.

Lectures will be given on general introduction (4h), fluid dynamics (2h), complex flow behavior (4h), influence of temperature (2h), rheometers (4h), rheological tests (6h) and structure and rheology of complex fluids (4h).

#### Objective

- To revive the knowledge of the basic operations of food technology and to become acquainted with the principles and use of several advanced technologies.
- To be able to quantitatively apply physical principles in the optimization of food processing and in the prediction of the shelf life of foods.
- To be able to assess and select technologies to achieve specific aims in food processing and development.
- To develop a basic understanding of contextual aspects impacting the work practice of food technologists and food developers.
- To gain experience in the development of an R&D project in the wider food area.

#### Content

- **I. Introduction**
  - I.1 Historical aspects of food technology
  - I.2 Processes, ingredients, products, systems
  - I.3 Food technology and food science
  - I.4 Impact of food technology on the modern diet
  - I.5 Global food: current situation and possible trends

- **II. Engineering approaches in food technology**
  - II.1 Phase transitions in foods
  - II.2 The state diagram
  - II.3 The state diagram in relation to food processing and food stabilization
  - II.4 Materials science of water in foods
  - II.5 Encapsulation and delivery of bioactive ingredients

- **III. Food technology context**
  - III.1 Elements of project management
  - III.2 Intellectual property
  - III.3 Food technology and nutrition
  - III.4 Interface with food sustainability
  - III.5 Cooking & artisanal food preparation

- **IV. Project work**
  - IV.1 Idea formulation
  - IV.2 Exploration of scientific and technological background
  - IV.3 Development of project approaches
  - IV.4 Presentation of project and preparation of written proposal

#### Literature

Provided in the lecture notes.

Notes will be handed out during the lectures.

#### Prerequisites / notice

VT I-III

#### Notes

- To gain experience in the development of an R&D project in the wider food area.
- To be able to assess and select technologies to achieve specific aims in food processing and development.
- To develop a basic understanding of contextual aspects impacting the work practice of food technologists and food developers.
- To gain experience in the development of an R&D project in the wider food area.

#### Lecture notes

Notes will be handed out during the lectures.

List of ca. 30 papers and 5 books given in course.

#### Data: 06.11.2018 12:57 Autumn Semester 2016 Page 885 of 1571
The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on process measurements and automation. A selection of approximately 20 papers from recent primary scientific literature.

**ECTS**
2V+1U

Lecturers
M. Dettling

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**Prerequisites / notice**

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.

**Number**
401-0649-00L

**Title**
Applied Statistical Regression

**Type**
W+

**ECTS**
5 credits

**Hours**
2V+1U

**Lecturers**
M. Dettling

**Abstract**
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

**Objective**
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

**Content**
The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

**Literature**
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

**Prerequisites / notice**
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

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**Optional Subjects**

**Number**
752-1301-00L

**Title**
Special Topics in Toxicology

**Type**
W

**ECTS**
2 credits

**Hours**
2G

**Lecturers**
S. J. Sturla, K. Hecht

**Abstract**
Journal-club style course involving student presentations and active discussion and critique of recent publications and modern experimental strategies. The focus is on chemical, biochemical, and nutritional aspects of selected topics in Toxicology, with a new group of topics addressed each semester.

**Objective**
- to stimulate student interest and provide advanced knowledge of current research in Toxicology and its related sciences
- to develop skills in critical evaluation of scientific literature, oral presentation and questioning
- to understand modern experimental techniques and research approaches relevant in toxicology

**Content**
The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on chemical, biochemical, and nutritional aspects of selected current topics in Toxicology. Participants are masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Biochemistry, Pharmaceutical Sciences, etc.).

**Literature**
A selection of approximately 20 papers from recent primary scientific literature.

**Prerequisites / notice**
The course is open to Masters or PhD level students.

For Masters level participants, a strict prerequisite is (a) previously taken and passed "Introduction to Molecular Toxicology" (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission.

If you would like to take "Special Topics in Toxicology", do not register at the same time for "Advanced Topics in Toxicology". It is only possible to take one, and it is only possible to take the advanced level after completing this course.

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**Major in Food Quality and Safety**

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**Disciplinary Subjects**

**Number**
752-0801-00L

**Title**
Food Law and Legislation

**Type**
W+

**ECTS**
1 credit

**Hours**
1V

**Lecturers**
C. Spinner, E. Zbinden Kaessner

**Abstract**
Principles of the Swiss food law, introduction to the principles of the EU, international organisations and international contracts.
Overview about the general principles, institutions and execution of the Swiss food law as well as a presentation of the most important regulations of the Swiss food legislation. Knowledge about the principles and the structure of the EU in general and in the area of food safety, overview on the bilateral agreements CH-EU as well as on the most important international organisations (Codex Alimentarius and WTO) and their influence on the Swiss regulations on food safety.

General introduction into the EU and in the area of food safety (Directorate General SANCO, regulation on food safety), legislative procedure in the EU, introduction into the relevant bilateral agreements CH-EU, introduction into international organisations (e.g. Codex Alimentarius), general principles of the Swiss food law and the most important regulations as well as the most important legal procedures, legal settlement and the duties and responsibilities of the Food control authorities.

Documents about Codex Alimentarius, the EU as well as the Swiss food law and some regulations will be handed out.

Qualifications: General knowledge of the food sciences.

The lecture will be held in German.

The course covers the fundamentals of food enzymology, application of endogenous and exogenous enzymes in food processing, as well as use of enzymes in analytics.

To understand use of enzymes in food processing and analysis.

Enzymes in foods: the use of added enzymes in food processing, control and/or utilization of endogenous enzymes, production of enzyme preparations for food use, and chemical analysis of food components by enzymatic methods.

The lectures are supplemented with handouts.

Course prerequisites: Food Chemistry I/II and Food Analysis I/II (or equivalent)

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on occurrence and survival of these organisms in foods.

To understand the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with these potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!

This integration course will discuss new applications of microorganisms with functional properties in food and functional food products.

To understand use of enzymes in analytics.

Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

A list of references will be given at the beginning of the course for the different topics presented during this course.
Prerequisites / notice
The course is open to Masters or PhD level students.

For Masters level participants, a strict prerequisite is (a) previously taken and passed "Introduction to Molecular Toxicology" (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission.

If you would like to take "Special Topics in Toxicology", do not register at the same time for "Advanced Topics in Toxicology". It is only possible to take one, and it is only possible to take the advanced level after completing this course.

▌▌ Methodology Subjects

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<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>401-0625-01L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W+</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>L. Meier</td>
</tr>
</tbody>
</table>

Abstract

Objective
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content

Literature

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>401-0649-00L</td>
<td>Applied Statistical Regression</td>
<td>W+</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>M. Dettling</td>
</tr>
</tbody>
</table>

Abstract
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content
The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

▌▌ Optional Subjects

<table>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>752-5111-00L</td>
<td>Gene Technology in Foods</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>L. Meier</td>
</tr>
</tbody>
</table>

Abstract
This course will increase basic knowledge on biotechnological constructions and application of genetically modified organisms (GMO) which are used worldwide in food production systems. The course discusses health issues, the legislation frame and food safety aspects of GMO applications in agriculture, food production and consumption in Switzerland and EU-countries.

Objective
This course will provide knowledge and biological background on genetically modified organisms (GMO) and food produced with the help of GMO, especially on the molecular basis of GMO constructions with emphasis on genetically modified food in Switzerland and the EU. Criteria of rationale food safety and health assessment in agriculture and food consumption will be elaborated.

Content
Overview on application in gene technology, the gene transfer potential of bacteria, plants and other organisms and the mostly used transgenes in food as well as on GMO used for food production and their detection technologies in food; food safety assessment of GMO food; information on the legislation in Switzerland and EU-countries

Prerequisites / notice
Copies of slides from lectures will be provided

Literature
Actual publications from literature will be provided

Prerequisites / notice
Good knowledge in biology, especially in microbiology and molecular biology are prerequisites. Some contents will be provided by registered students who will individually or as a group present an actual publication.

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-1302-00L</td>
<td>Advanced Topics in Toxicology</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>S. J. Sturla</td>
</tr>
</tbody>
</table>

Abstract
Journal-club style course that involves student presentations of selected topics in Toxicology on the basis of current primary research and review papers.

Objective
The goals are to stimulate student interest and provide advanced knowledge of current research in the interdisciplinary area of Food and Nutrition Toxicology and its related sciences. The student should develop skills in the critical evaluation of scientific literature, oral presentation and questioning, and understanding modern experimental techniques in Molecular Toxicology.

Content
The journal-club style course involves student presentations of recent publications. The primary focus is on chemical and biochemical aspects of selected topics in Toxicology. Participants are generally masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Pharmaceutical Sciences, etc.), and strong knowledge of organic chemistry and biochemistry are prerequisite. Selected course topics change every semester.

Prerequisites / notice
Participants are required to have completed previously "Special Topics in Toxicology" (752-1301-00L). Both courses are run concurrently every semester. It is only possible to register for one course at a time. Do not register for "Advanced Topics in Toxicology" until after you have completed "Special Topics in Toxicology"

▌▌ Major in Nutrition and Health

▌▌ Disciplinary Subjects
Nutritional Aspects of Food Composition and Processing

**Abstract**
Lecture type course with an interdisciplinary approach for the evaluation of nutritional aspects of changes in food composition due to processing.

**Objective**
Students should be able to:
- describe and compare the major concepts /criteria used for the evaluation of the nutritional quality of food
- apply these criteria when assessing the effects of selected processing technologies on nutritional quality.
- evaluate recent formulation strategies aimed to achieve additional physiological benefits for targeted population groups (i.e. functional foods).

**Content**
The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g. nutritional profile) will be addressed.

**Lecture notes**
There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course.

**Prerequisites / notice**
The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing.

---

Dietary Etiologies of Chronic Disease

**Abstract**
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Objective**
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

**Content**
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Lecture notes**
There is no script. Powerpoint presentations will be made available on-line to students.

**Literature**
To be provided by the individual lecturers, at their discretion.

**Prerequisites / notice**
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

---

Epidemiology and Prevention

**Abstract**
The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.

**Objective**
The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.

**Content**
The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

---

Nutrigenomics - toward personalized nutrition?

**Abstract**
Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.

**Objective**
- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.
- Overall understanding of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.
- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics

**Content**
- For the content of the script see section "Skript" below
- The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.
The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules

Module A
From biochemical nutrition research to nutrigenomics

Module B
Nutritional genomics

Module C
Nutrigenetics

Module D
Nutri-epigenomics

Module E
Transcriptomics in nutrition research

Module F
Proteomics in nutrition research

Module G
Metabolomics in nutrition research

Module H
Nutritional systems biology

Module I
Individualized nutrition - opportunities and challenges

No extra reading requested. Most slides in the lecture are referenced with web addresses.

Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.

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<td>5 credits</td>
<td>2V+1U</td>
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<td>The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.</td>
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<tr>
<td>Literature</td>
<td>Faraway (2005): Linear Models with R</td>
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<td></td>
<td>Faraway (2006): Extending the Linear Model with R</td>
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<td>Draper &amp; Smith (1998): Applied Regression Analysis</td>
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<td></td>
<td>Fox (2008): Applied Regression Analysis and GLMs</td>
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<tr>
<td></td>
<td>Montgomery et al. (2006): Introduction to Linear Regression Analysis</td>
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<tr>
<td>766-6205-00L</td>
<td>Nutrient Analysis in Foods</td>
<td>W</td>
<td>3 credits</td>
<td>3U</td>
<td>M. B. Zimmermann, V. Galetti</td>
</tr>
<tr>
<td>Prerequisites/notice</td>
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<tr>
<td>Literature</td>
<td>In this practical course different meals are prepared and then analysed in the laboratory. The analyses comprise energy, macronutrients, specific micronutrients as well as polyphenols and phytic acid. Based on these results, the nutritional value of each meal is critically evaluated and discussed.</td>
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<td></td>
<td>Learning analytical methods to determine macro- and micronutrient content in foods. Critical evaluation of analytical results, critical comparison with values from food composition tables, and interpretation in relation to nutritional value of meals.</td>
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</table>
Content
The practical course nutrient analysis in foods includes the meal preparation (2 hours in December 2016, date to be defined) and chemical analysis of five meals from 5 different types of diets (students will work in groups; one meal per group). The content of macronutrients, specific micronutrients and secondary plant components are analysed using common analytical methods. The analytical results are compared with calculated data from food composition databases by using the nutrition software EbisPro and critically evaluated. The nutritional values of the meals in relation to specific chronic diseases and iron bioavailability are discussed. The practical course is accompanied by a lecture on the basic principles of analytical chemistry.

Lecture notes
A script and lecture slides are handed out before course start.

Prerequisites / notice
Students will work in groups.
Performance is assessed by a short test on course content, oral presentation or results and a short report.
Attendance in compulsory for the lecture, the laboratory work, and the oral presentation.

Optional Subjects

<table>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>752-5103-00L</td>
<td>Functional Microorganisms in Foods</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>C. Lacroix. T. de Wouters, L. Meile, C. Schwab</td>
</tr>
</tbody>
</table>

Abstract
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

Objective
To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

Content
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Probiotics

Students will be required to complete a group project on food products and ingredients with or from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

Lecture notes
Copy of the power point slides from lectures will be provided.

Literature
A list of references will be given at the beginning of the course for the different topics presented during this course.

<table>
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<tbody>
<tr>
<td>752-6301-00L</td>
<td>Selected Topics in Physiology Related to Nutrition</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>W. Langhans</td>
</tr>
</tbody>
</table>

Abstract
Gives the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand.

Objective
Some basic knowledge in physiology is recommended for this course, which revisits important physiological topics, emphasizing their relation to nutrition. The aim is to give the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand. For students with a background in medicine, pharmacy or biology, the course is useful as a review of previously acquired knowledge. Major topics are basic neuroanatomy and neurophysiology; general endocrinology; the physiology of taste and smell; nutrient digestion and absorption; intermediary metabolism and energy homeostasis; and some aspects of cardiovascular physiology and water balance.

Lecture notes
Handouts for each lecture will be made available every week; http://www.fpb.ethz.ch/teaching/handouts.html

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<tr>
<td>752-6403-00L</td>
<td>Nutrition and Performance</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>S. Mettler, M. B. Zimmermann</td>
</tr>
</tbody>
</table>

Abstract
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

Objective
To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

Content
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intense exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Lecture notes
Lecture slides and required handouts will be available on the ETH website.

Literature
Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

Prerequisites / notice
General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English
It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

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<td>Gene Technology in Foods</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>L. Meile</td>
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Abstract
This course will increase basic knowledge on biotechnological constructions and application of genetically modified organisms (GMO) which are used worldwide in food production systems. The course discusses health issues, the legislation frame and food safety aspects of GMO applications in agriculture, food production and consumption in Switzerland and EU-countries.

Objective
This course will provide knowledge and biological background on genetically modified organisms (GMO) and food produced with the help of GMO, especially on the molecular basis of GMO constructions with emphasis on genetically modified food in Switzerland and the EU. Criteria of rationale food safety and health assessment in agriculture and food consumption will be elaborated.
Content: Overview on application in gene technology, the gene transfer potential of bacteria, plants and other organisms and the mostly used transgenes in food as well as on GMO used for food production and their detection technologies in food; food safety assessment of GMO food; information on the legislation in Switzerland and EU-countries.

Lecture notes: Copies of slides from lectures will be provided.

Literature: Actual publications from literature will be provided.

Prerequisites / notice: Good knowledge in biology, especially in microbiology and molecular biology are prerequisites. Some contents will be provided by registered students who will individually or as a group present an actual publication.

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<tbody>
<tr>
<td>752-1300-00L</td>
<td>Special Topics in Toxicology</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>S. J. Sturua, K. Hecht</td>
</tr>
<tr>
<td>Abstract</td>
<td>Journal-club style course involving student presentations and active discussion and critique of recent publications and modern experimental strategies. The focus is on chemical, biochemical, and nutritional aspects of selected topics in Toxicology, with a new group of topics addressed each semester.</td>
<td></td>
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</table>
| Objective   | - to stimulate student interest and provide advanced knowledge of current research in Toxicology and its related disciplines. 
- to develop skills in critical evaluation of scientific literature, oral presentation and questioning 
- to understand modern experimental techniques and research approaches relevant in Toxicology. |
| Content     | The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on chemical, biochemical, and nutritional aspects of selected current topics in Toxicology. Participants are masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Biochemistry, Pharmaceutical Sciences, etc.). |
| Literature  | A selection of approximately 20 papers from recent primary scientific literature. |
| Prerequisites / notice | The course is open to Masters or PhD level students. |

If you would like to take "Special Topics in Toxicology", do not register at the same time for "Advanced Topics in Toxicology". It is only possible to take one, and it is only possible to take the advanced level after completing this course.

### Major in Human Health, Nutrition and Environment

Definition of modules see study guide Food Science


#### Disciplinary Subjects

Disciplinary courses: Module Public Health plus one additional module (Infectious Diseases or Nutrition and Health or Environment and Health). A minimum of 10 CP per module have to be obtained.

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<tbody>
<tr>
<td>401-0629-00L</td>
<td>Applied Biostatistics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Müller</td>
</tr>
<tr>
<td>Abstract</td>
<td>Principles and main methods in biostatistics with emphasis on practical aspects. Experimental and observational studies. Regression and analysis of variance. Introduction into survival analysis.</td>
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<tr>
<td>Objective</td>
<td>Getting an overview of the problems and statistical methods used in health sciences. Practise in using the software R to analyze data and interpreting the results.</td>
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<tr>
<td>Literature</td>
<td>see teaching document repository</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The statistical package R will be used in the exercises.</td>
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If you are unfamiliar with R, I highly recommend the online R course etutoR.

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<tr>
<td>551-0223-00L</td>
<td>Immunology III</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>M. Kopf, M. Bachmann, J. Kisielow, A. Lanzavecchia, S. R. Leibundgut, A. Oxenius, R. Spörri</td>
</tr>
</tbody>
</table>
| Abstract    | This course provides a detailed understanding of 
- development of T and B cells 
- the dynamics of a immune response during acute and chronic infection 
- mechanisms of immunopathology 
- modern vaccination strategies 
Key experimental results will be shown to help understanding how immunological text book knowledge has evolved. |
| Objective   | Obtain a detailed understanding of 
- the development, activation, and differentiation of different types of T cells and their effector mechanisms during immune responses, 
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter, 
- evens and signals for maturation of naïve B cells to antibody producing plasma cells and memory B cells. 
Optimization of B cell responses by intelligent design of new vaccines |
| Content     | o Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg) 
o NK T cells and responses to lipid antigens 
o Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17 
o Overview of cytokines and their effector function 
o Co-stimulation (signals 1-3) 
o Dendritic cells 
o Evolution of the "Danger" concept 
o Cells expressing Pattern Recognition Receptors and their downstream signals 
o T cell function and dysfunction in acute and chronic viral infections |
| Literature  | Documents of the lectures are available for download at: |
| Prerequisites / notice | Immunology I and II recommended but not compulsory |

For Masters level participants, a strict prerequisite is (a) previously taken and passed "Introduction to Molecular Toxicology" (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission.

If you would like to take "Special Topics in Toxicology", do not register at the same time for "Advanced Topics in Toxicology". It is only possible to take one, and it is only possible to take the advanced level after completing this course.

- Immunology III
- Applied Biostatistics
- Disciplinary courses: Module Public Health plus one additional module (Infectious Diseases or Nutrition and Health or Environment and Health). A minimum of 10 CP per module have to be obtained.
- Immunology I and II recommended but not compulsory.

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 892 of 1571
## Water Resources and Drinking Water

**Abstract**
Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.

**Objective**
This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

**Content**
A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

**Lecture notes / Literature**
Papers will be assigned and downloaded from a web page announced during the lecture.

### 701-1341-00L Water Resources and Drinking Water

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Semester</th>
<th>Credits</th>
<th>Lecture Notes / Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3</td>
<td>Handsouts will be distributed</td>
</tr>
</tbody>
</table>

**Prerequisites / Notice**
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!

## Food and Consumer Behaviour

**Abstract**
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

**Objective**
The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

**Content**
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

**Lecture notes / Literature**
Handouts will be distributed

### 752-2122-00L Food and Consumer Behaviour

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
<th>Lecture Notes / Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W</td>
<td>2</td>
<td>Lecture notes / Notice</td>
</tr>
</tbody>
</table>

**Prerequisites / Notice**
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!

## Molecular Biology of Foodborne Pathogens

**Abstract**
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

**Objective**
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

**Content**
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

**Lecture notes / Literature**
Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

### 752-4009-00L Molecular Biology of Foodborne Pathogens

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
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</tr>
</thead>
<tbody>
<tr>
<td>752-4009-00L</td>
<td>Molecular Biology of Foodborne Pathogens</td>
<td>W</td>
<td>3</td>
<td>Handouts will be distributed</td>
</tr>
</tbody>
</table>

**Prerequisites / Notice**
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!

## Functional Microorganisms in Foods

**Abstract**
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of microorganisms to produce food with high quality, safety and potential health benefits for consumers.

**Objective**
To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

**Content**
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:
- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Probiotics

**Lecture notes / Literature**
A list of references will be given at the beginning of the course for the different topics presented during this course.

### 752-5103-00L Functional Microorganisms in Foods

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Semester</th>
<th>Credits</th>
<th>Lecture Notes / Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-5103-00L</td>
<td>Functional Microorganisms in Foods</td>
<td>W</td>
<td>3</td>
<td>Copy of the power point slides from lectures will be provided</td>
</tr>
</tbody>
</table>

**Prerequisites / Notice**
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!

## Dietetic Etiologies of Chronic Disease

**Abstract**
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Objective**
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

### 752-6101-00L Dietetic Etiologies of Chronic Disease

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Semester</th>
<th>Credits</th>
<th>Lecture Notes / Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6101-00L</td>
<td>Dietetic Etiologies of Chronic Disease</td>
<td>W</td>
<td>3</td>
<td>A list of references will be given at the beginning of the course for the different topics presented during this course.</td>
</tr>
</tbody>
</table>

**Prerequisites / Notice**
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!

Data: 06.11.2018 12:57
Autumn Semester 2016
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### Content
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

### Literature
To be provided by the individual lecturers, at their discretion.

### Prerequisites / notice
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I-II) is strongly advised.

### 752-6105-00L  Epidemiology and Prevention

**Information for UZH students:**
Enrolment to this course unit only possible at ETH. No enrolment to module CS16_101 at UZH.

*Please mind the ETH enrolment deadlines for UZH students: https://www.ethz.ch/en/studies/non-degree-courses/special-students/special-students-university-of-zurich.html*

**Abstract**
The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.

**Objective**
The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.

**Content**
The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples from nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

### 752-6151-00L  Public Health Concepts

**Abstract**
The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

**Objective**
At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

**Content**
Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

**Lecture notes**
Handouts are provided to students in the classroom.

### 752-6402-00L  Nutrigenomics

**Abstract**
Nutrigenomics - toward personalized nutrition?
Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.

**Objective**
- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.
- Overall understating of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.
- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics

**Content**
- For the content of the script see section "Skript" below
- The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.

**Lecture notes**
The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules

**Module A**
From biochemical nutrition research to nutrigenomics

**Module B**
Nutritional genomics

**Module C**
Nutrigenetics

**Module D**
Nutri-epigenomics

**Module E**
Transcriptomics in nutrition research

**Module F**
Proteomics in nutrition research

**Module G**
Metabolomics in nutrition research

**Module H**
Nutritional systems biology

**Module I**
Individualized nutrition - opportunities and challenges

**Literature**
No extra reading requested. Most slides in the lecture are referenced with web adresses.
Methodology Subjects

Methodical courses are equivalent to the module Term Paper and Seminar. Missing CPs can be obtained from the major programs Food Processing, Food Quality and Safety, or Nutrition and Health.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract
Writing of a review paper of scientific quality on a topic in the domain of Human Health, Nutrition and Environment based on critical evaluation of scientific literature.

Objective
- Acquisition of knowledge in the field of the review paper
- Assessment of original literature as well as synthesis and analysis of the findings
- Practising of academic writing in English
- Giving an oral presentation with discussion on the topic of the review paper

Content
Topics are offered in the domains of the major 'Human Health, Nutrition and Environment' covering 'Public Health', 'Infectious Diseases', 'Nutrition and Health' and 'Environment and Health'.

Lecture notes
Guidelines will be handed out in the beginning.

Literature
Literature will be identified based on the topic chosen.

Optional Subjects

Choice of a module not yet selected as a disciplinary course. Choice between Infectious Diseases, Nutrition and Health, and Environment and Health.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-4009-00L</td>
<td>Molecular Biology of Foodborne Pathogens</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>M. Loessner, M. Schuppler</td>
</tr>
</tbody>
</table>

Abstract
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

Content
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

Lecture notes
Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

Literature
Recommendations will be given in the first lecture

Prerequisites / notice
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!

551-0223-00L Immunology III

Abstract
This course provides a detailed understanding of
- development of T and B cells
- the dynamics of an immune response during acute and chronic infection
- mechanisms of immunopathology
- modern vaccination strategies
Key experimental results will be shown to help understanding how immunological text book knowledge has evolved.

Objective
Obtain a detailed understanding of
- the development, activation, and differentiation of different types of T cells and their effector mechanisms during immune responses,
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter,
- events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells. 
- Optimization of B cell responses by intelligent design of new vaccines

Content
- Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
- NK T cells and responses to lipid antigens
- Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
- Overview of cytokines and their effecter function
- Co-stimulation (signals 1-3)
- Dendritic cells
- Evolution of the "Danger" concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunction in acute and chronic viral infections

Literature
Documents of the lectures are available for download at: https://moodle-app2.let.ethz.ch/course/view.php?id=2581&notifyeditingon=1

Prerequisites / notice
Immunology I and II recommended but not compulsory

701-0263-001L Seminar in Evolutionary Ecology of Infectious Diseases

Abstract
Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occuring in the field.

Objective
This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

Content
A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.
**Lecture notes**
Publications and class notes can be downloaded from a web page announced during the lecture.
Papers will be assigned and downloaded from a web page announced during the lecture.

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Lecture Type</th>
<th>Instructor(s)</th>
</tr>
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<tbody>
<tr>
<td>752-6101-00L</td>
<td><strong>Dietary Etiologies of Chronic Disease</strong></td>
<td>3</td>
<td>W</td>
<td>M. B. Zimmermann</td>
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<tr>
<td><strong>Abstract</strong></td>
<td>To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>There is no script. Powerpoint presentations will be made available on-line to students.</td>
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<td></td>
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<tr>
<td><strong>Literature</strong></td>
<td>To be provided by the individual lecturers, at their discretion.</td>
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<td></td>
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</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.</td>
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<tr>
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<th>Pre-requisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6402-00L</td>
<td><strong>Nutrigenomics</strong></td>
<td>3</td>
<td>W</td>
<td>G. Vergères</td>
<td>Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.</td>
</tr>
</tbody>
</table>
| **Abstract** | Nutrigenomics - toward personalized nutrition?  
Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.  
- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.  
- Overall understating of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.  
- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics  
- For the content of the script see section "Skript" below  
- The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.  

**Lecture notes**  
The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules  

- Module A  
  From biochemical nutrition research to nutrigenomics  

- Module B  
  Nutritional genomics  

- Module C  
  Nutrigenetics  

- Module D  
  Nutri-epigenomics  

- Module E  
  Transcriptomics in nutrition research  

- Module F  
  Proteomics in nutrition research  

- Module G  
  Metabolomics in nutrition research  

- Module H  
  Nutritional systems biology  

- Module I  
  Individualized nutrition - opportunities and challenges  

**Literature**  
No extra reading requested. Most slides in the lecture are referenced with web adresses.  

**Prerequisites / notice**  
Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.  

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</thead>
<tbody>
<tr>
<td>752-5103-00L</td>
<td><strong>Functional Microorganisms in Foods</strong></td>
<td>3</td>
<td>G</td>
<td>C. Lacroix, T. de Wouters, L. Meile, C. Schwab</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.</td>
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Content
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:
- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Probiotics

Lecture notes
Copy of the power point slides from lectures will be provided.

Literature
A list of references will be given at the beginning of the course for the different topics presented during this course.

752-2122-00L Food and Consumer Behaviour
W 2 credits 2V M. Siegrist, C. Hartmann

Objective
This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.

Literature
The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues

701-1341-00L Water Resources and Drinking Water

Objective
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

Literature
The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

763-0017-00L Computational Biology
W 4 credits 3G T. Stadler, C. Magnus

Objective
The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.

Literature
The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm). GWAS approaches. Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

701-1703-00L Evolutionary Medicine for Infectious Diseases
W 3 credits 2G A. Hall

Objective
This course explores infectious disease from both the host and pathogen perspective. Through short lectures, reading and active discussion, students will identify areas where evolutionary thinking can improve our understanding of infectious diseases and, ultimately, our ability to treat them effectively.

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

Students will learn to (i) identify evolutionary explanations for the origins and characteristics of infectious diseases in a range of organisms and (ii) evaluate ways of integrating evolutionary thinking into improved strategies for treating infections of humans and animals. This will incorporate principles that apply across any host-pathogen interaction, as well as system-specific mechanistic information, with particular emphasis on bacteria and viruses.
We will cover several topics where evolutionary thinking is relevant to understanding or treating infectious diseases. This includes: (i) determinants of pathogen host range and virulence, (ii) dynamics of host-parasite coevolution, (iii) pathogen adaptation to evade or suppress immune responses, (iv) antimicrobial resistance, (v) evolution-proof medicine. For each topic there will be a short (< 30 minutes) introductory lecture, before students independently research the primary literature and develop half a page of discussion points and questions, followed by interactive discussion in class.

Students will read the primary literature on each topic, and in places we will use the following books:

Schmid Hempel 2011 Evolutionary Parasitology
Stearns & Medzhitov 2016 Evolutionary Medicine

A basic understanding of evolutionary biology, microbiology or parasitology will be advantageous but is not essential.

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1471-00L</td>
<td>Ecological Parasitology</td>
<td>W</td>
<td>3 credits</td>
<td>1V+1P</td>
<td>O. E. Seppälä, H. Hartikainen, J. Jokela</td>
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</tbody>
</table>

**Minors**

**Food Biotechnology**

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-5105-00L</td>
<td>Biotechnology of Alcoholic Beverages</td>
<td>W+</td>
<td>2 credits</td>
<td>2V</td>
<td>H. J. Gafner, S. Schönemberg</td>
</tr>
</tbody>
</table>

**Prerequisites / notice**

Sound knowledges in microbiology, molecular genetics, biochemistry and physiology in fermentd beverages are required.

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<tr>
<th>Number</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>752-5111-00L</td>
<td>Gene Technology in Foods</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>L. Meile</td>
</tr>
</tbody>
</table>

**Prerequisites / notice**

Good knowledge in biology, especially in microbiology and molecular biology are prerequisites. Some contents will be provided by registered students who will individually or as a group present an actual publication.
Functional Microorganisms in Foods

**Abstract**
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

**Objective**
To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

**Content**
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- **Probiotics and Prebiotics:** Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.

- **Bioprotective Cultures and Antimicrobial Metabolites:** Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.

- **Legal and Protection Issues Related Functional Foods**

- **Industrial Biotechnology of Flavor and Taste Development**

- **Safety of Food Starter Cultures and Prebiotics**

**Lecture notes**
Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

**Literature**
A list of references will be given at the beginning of the course for the different topics presented during this course.

### Food Chemistry

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
---|---|---|---|---|---
752-1021-00L | Food Enzymology | W+ | 3 credits | 2G | L. Nyström

**Abstract**
The course covers the fundamentals of food enzymology, application of endogenous and exogenous enzymes in food processing, as well as use of enzymes in analytics.

**Objective**
To understand use of enzymes in food processing and analysis.

**Content**
Enzymes in foods: the use of added enzymes in food processing, control and/or utilization of endogenous enzymes, production of enzyme preparations for food use, and chemical analysis of food components by enzymatic methods.

**Lecture notes**
The lectures are supplemented with handouts.

**Prerequisites / notice**
Course prerequisites: Food Chemistry I/II and Food Analysis I/II (or equivalent)

529-0041-00L | Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics | W | 6 credits | 3G | R. Zenobi, M. Badertscher, B. Hattendorf, P. Martinez-Lozano Sinués

**Abstract**
Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics.

**Objective**
Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

**Content**
Coupung of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation. Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods. Methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods). Employment of computer science for processing data in chemical analysis (chemometrics).

**Lecture notes**
lecture notes will be available in the lecture at production cost.

**Prerequisites / notice**
Information about relevant literature will be available in the lecture & in the lecture notes. Exercises are an integral part of the lecture.

**Prerequisites**
529-0051-00 "Analytische Chemie I (3. Semester)"
529-0058-00 "Analytische Chemie II (4. Semester)"
(or equivalent)

### Food Microbiology

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
---|---|---|---|---|---
752-4009-00L | Molecular Biology of Foodborne Pathogens | W+ | 3 credits | 2V | M. Loessner, M. Schuppler

**Abstract**
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

**Objective**
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

**Content**
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

**Lecture notes**
Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

**Literature**
Recommendations will be given in the first lecture

**Prerequisites / notice**
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!
### Food Process Design

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</thead>
<tbody>
<tr>
<td>752-3021-00L</td>
<td>Food Process Design and Optimization</td>
<td>W+</td>
<td>4 credits</td>
<td>2G</td>
<td>E. J. Windhab</td>
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<tr>
<td></td>
<td>Training by case studies from research and industrial production.</td>
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#### Objective
- Quantitative process analysis and derivation of process-structure functions for complex liquid or semi-liquid food systems with non-Newtonian flow properties. Handling of optimisation and up-/down-scaling procedures.

#### Content
- S-PRO2 scheme, reverse engineering approach, dimension analysis, Metzner-Otto and Rieger Novack design schemes of stirred reactors for non-Newtonian fluid processing, mixing/mixing statistics, mixing characteristics, power characteristic, dispersing characteristics, dispersing processes in rotor/ stator and membrane devices, spray processing, extrusion processing, diverse case studies for design and scaling of processes for food structure processing

#### Lecture notes
- Printed handouts (ca. 180)

#### Literature
- List of ca. 30 papers and 5 books given in course

#### Prerequisites / notice
- VT I-III

### Food Sensory Science and Consumer Behaviour

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<tr>
<th>Number</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>752-3023-00L</td>
<td>Process Measurements and Automation</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>E. J. Windhab</td>
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<td></td>
<td>Overview on Process Automation, Information Management in processes, process data handling and analysis, In-line measurements of complex food systems, Process control schemes, Overview of sensors and sensor principles, integrated process control case studies</td>
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<td>Understanding the interplay of in-line measurements of complex food properties in processes, process data handling and data analysis as well as building blocks for process control.</td>
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#### Objective
- Understanding the interplay of in-line measurements of complex food properties in processes, process data handling and data analysis as well as building blocks for process control.

#### Content
- Overview Process Automation, Process Control and process data management, Industrial design of automated/controlled processes, overview on sensors/sensor principles, case studies of in-line measurements and control in/of food production processes

#### Lecture notes
- Printed script (120 pages, 80 figures), diverse publications

#### Literature
- List of publications and books given in course

#### Prerequisites / notice
- VT I-III

### Public Nutrition and Health

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<tr>
<th>Number</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>752-6101-00L</td>
<td>Dietary Etiologies of Chronic Disease</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>M. B. Zimmermann</td>
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<td></td>
<td>To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</td>
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<td></td>
<td>To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.</td>
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</table>

#### Objective
- To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

#### Content
- The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

#### Lecture notes
- There is no script. Powerpoint presentations will be made available on-line to students.

#### Literature
- To be provided by the individual lecturers, at their discretion.

#### Prerequisites / notice
- No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.
Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate

Horticultural Science: Case Studies (HS)

L. Bertschinger, C. Hartmann

This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.

Title

Epidemiology and Prevention

Food and Consumer Behaviour

Safety and Quality in Agri-Food Chain

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<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>752-6105-00L</td>
<td>Epidemiology and Prevention</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Puhan, R. Heusser</td>
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<td>Information for UZH students:</td>
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<td>Enrolment to this course unit only possible at ETH. No enrolment to module CS16_101 at UZH.</td>
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<td>Please mind the ETH enrolment deadlines for UZH students: <a href="https://www.ethz.ch/en/studies/non-degree-courses/special-students-university-of-zurich.html">https://www.ethz.ch/en/studies/non-degree-courses/special-students-university-of-zurich.html</a></td>
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<tr>
<td>Abstract</td>
<td>The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.</td>
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<tr>
<td>Objective</td>
<td>The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.</td>
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<tr>
<td>Content</td>
<td>The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.</td>
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<tr>
<td>752-1555-00L</td>
<td>Applied Food Industrial Organisation</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>to be announced</td>
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<tr>
<td>Abstract</td>
<td>Concepts of microeconomics and Industrial Organization and their application to the European food sector. Aspects include industry structure as well as strategic actions and performance of food sector firms.</td>
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<tr>
<td>Objective</td>
<td>Understanding and application of theoretical concepts along the Structure-Conduct-Performance paradigm. Ability to apply theory to empirical settings; understand and critically evaluate empirical industrial organization research and to replicate the results of such research using econometric methods.</td>
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</table>
| Content     | - Introduction IO  
- Relevant topics for the food sector  
- high competition and market saturation  
- low R&D intensity  
- bargaining power of retailers  
- Private label introduction  

- Theoretical Approaches  
  - Structure Conduct Performance  
  - Market Based View  
  - Porters Five Forces  
  - Resource Based View  
  - Knowledge Based View  

- Empirical Issues (Based on published research papers)  
  - Competition / Concentration  
  - Profitability  
  - Impact of Innovation / R&D  
  - Efficiency  
  - Market power  
  - Econometric Approaches  

Literature

Several theoretical and empirical IO related research papers |
| 752-2122-00L | Food and Consumer Behaviour                 | W    | 2 credits | 2V    | M. Siegrist, C. Hartmann |
| Abstract    | This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products. |      |      |       |                        |
| Objective   | The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues |      |      |       |                        |
| 752-2307-00L | Nutritional Aspects of Food Composition and Processing | W+   | 3 credits | 2V    | B. E. Baumer, J. M. Sych |
| Abstract    | Lecture type course with an interdisciplinary approach for the evaluation of nutritional aspects of changes in food composition due to processing. |      |      |       |                        |
| Objective   | Students should be able to  
- describe and compare the major concepts /criteria used for the evaluation of the nutritional quality of food  
- apply these criteria when assessing the effects of selected processing technologies on nutritional quality.  
- evaluate recent formulation strategies aimed to achieve additional physiological benefits for targeted population groups (i.e. functional foods). |      |      |       |                        |
| Content     | The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g. nutritional profile) will be addressed. |      |      |       |                        |
| Lecture notes | There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course. |      |      |       |                        |
| Prerequisites / notice | The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing. |      |      |       |                        |
| 751-4203-00L | Horticultural Science: Case Studies (HS)   | W    | 2 credits | 2G    | L. Bertschinger, J. Rösti, V. J. U. Zufferey |
| Abstract    | Lectures address 2 horticultural cropping systems and value chains, each one in 4 2h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated before. An excursion to a research site might be included. In a final colloquium, each group presents a report on their case study and their conclusions. |      |      |       |                        |
| Objective   | Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy. |      |      |       |                        |
Content
In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture.
In the spring semester, the two addressed cropping systems and value chains are vegetable-production- and berry-production or glasshouse-horticulture.
The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and branch into ongoing research and development projects.

Lecture notes
Documents handed out during the case studies.

Literature
As provided by the case study leaders.

Prerequisites / notice
The course builds on basic knowledge delivered in ‘Horticultural Crops I’ and ‘Horticultural Crops II’. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student.
Language: spoken E, G or F, Documents: Preferably English, G/F possible.

751-6001-00L
Forum: Livestock in the World Food System

Abstract
This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.

Objective
In the Forum “Livestock in the World Food System”, a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.

Content
The Forum "Livestock in the World Food System" will take place in blocks of 2 hours each. Once the general topic has been selected, it comprises two elements:
Element 1. Oral Presentation: The students form small groups and are lecturers. There are chair persons (moderators) from outside of these small groups and they also head the discussion. The remaining students and lecturers are the audience.
Element 2. Scientific writing: Option 1: preparation of a short scientific type of paper from a result table offered by the lecturers; Option 2: preparation of an abstract with limited word count from a scientific paper; Option 3: writing of a critical review of a paper. The students have to select 2 of the three options each. There will be a discussion be a discussion in small groups at two dates.

4 credits
2V
M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neuenenschwander

751-5111-00L
Gene Technology in Foods

Abstract
This course will provide basic knowledge on biotechnological constructions and application of genetically modified organisms (GMO) which are used worldwide in food production systems. The course discusses health issues, the legislation frame and food safety aspects of GMO applications in agriculture, food production and consumption in Switzerland and EU-countries.

Objective
This course will provide knowledge and biological background on genetically modified organisms (GMO) and food produced with the help of GMO, especially on the molecular basis of GMO constructions with emphasis on genetically modified food in Switzerland and the EU. Criteria of rationale food safety and health assessment in agriculture and food consumption will be elaborated.

Content
Overview on application in gene technology, the gene transfer potential of bacteria, plants and other organisms and the mostly used transgenes in food as well as on GMO used for food production and their detection technologies in food; food safety assessment of GMO food; information on the legislation in Switzerland and EU-countries

752-6001-00L
World Food System Summer School

Number of participants limited to 25.

752-0021-00L
World Food System Summer School

Number of participants limited to 25.
It is necessary to apply and be selected in order to participate in this course. This also applies to ETH Zurich applicants, they will go through a competitive selection process and are not guaranteed a place simply by signing up for the course.

Further information available:
http://www.worldfoodsystem.ethz.ch/education/summer-schools/upcoming.html

Abstract
Provide the opportunity for young scientists and practitioners to understand the challenges and opportunities of sustainable agriculture and organic production systems and to connect these to the broader context of the world food system. During the two week summer school at the Gut Rheinau, one of Switzerland’s largest organic farms, participants will engage in lectures, workshops, group work, case

Objective
Understand: the science, relationships, interactions and trade-offs in food systems; the role and potential of organic production systems; potential interventions; the cultural, socio-political, economic and environmental factors to be incorporated into solutions. Build skills in systems thinking, multi-cultural and multi-disciplinary collaboration, participatory processes. Connect to a network of expert faculty/ scientists/ practitioners

Content
The content framework includes the following modules: world food system overview; agricultural production; Global change drivers; smallholder livelihoods and rural development; Agroforest systems; labelling; International policy and trade; Processing, distribution, and retail; Nutrition and health; National policy and state interventions. The course will conclude with a group work on food system challenges.

Literature
Documents will be provided from registred students who will individually or as a group present an actual publication.

Number of participants limited to 25.

Prerequisites / notice
Requirements for allocation of the two credit points:
- Theatre presentation (with handout) at the forum
- Delivery of written documents of sufficient quality
- Active participation during the presentations by the other participants

Language: spoken E, G or F, Documents: Preferably English, G/F possible.

752-5103-00L
Food Rheology I

W+ 3 credits 2V P. A. Fischer

Notice
Prerequisites / notice
No prerequisites. Program is open to Masters, PhD and upper level Bachelor students.

Notice
No prerequisites. Program is open to Masters, PhD and upper level Bachelor students.

Notice
Some contents will be provided by registred students who will individually or as a group present an actual publication.

Notice
Some contents will be provided by registred students who will individually or as a group present an actual publication.

Notice
No prerequisites. Program is open to Masters, PhD and upper level Bachelor students.

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Abstract

Rheology is the science of flow and deformation of matter such as polymers, dispersions (emulsions, foams, suspensions), and colloidal systems. The fluid dynamical basis, measuring techniques (rheometry), and the flow properties of different fluids (Newtonian, non-Newtonian, viscoelastic) are introduced and discussed.

Objective

The course provides an introduction on the link between flow and structural properties of flowing material. Rheometrical techniques and appropriate measuring protocols for the characterization of complex fluids will be discussed. The concept of rheological constitutive equations and the application to different material classes are established.

Content

Lectures will be given on general introduction (4h), fluid dynamics (2h), complex flow behavior (4h), influence of temperature (2h), rheometers (4h), rheological tests (6h) and structure and rheology of complex fluids (4h).

Lecture notes

Notes will be handed out during the lectures.

Literature

Provided in the lecture notes.

752-2314-00L

Physics of Food Colloids

W+ 3 credits 2V P. A. Fischer, R. Mezzenga

Abstract

In Physics of Food Colloids the principles of colloid science will applied to the aggregation of food materials based on proteins, polysaccharides, and emulsifiers. Mixtures of such raw material determine the appearance and performance of our daily food. In a number of examples, colloidal laws are linked to food science and the manufacturing and processing of food.

Objective

The aggregation of food material determines the appearance and performance of complex food systems as well as nutritional aspects. The underlying colloidal laws reflect the structure of the individual raw material (length scale, time scale, and interacting forces). Once these concepts are appreciated the aggregation of most food systems falls into recognizable patterns that can be used to modify and structure exiting food or to design new products. The application and use of these concepts are discussed in light of common food production.

Content

Lectures include interfacial tension (4h), protein aggregation in bulk and interfaces (4h), Pickering emulsions (2h), gels (4h), aggregation of complex mixtures (4h), and the use of light scattering in investigation complex food structures (6h). Most chapters include some hand-outs examples of the gain knowledge to common food products.

Lecture notes

Notes will be handed out during the lectures.

Literature

Provided in the lecture notes.

Food Toxicology

Number

Title

Type

ECTS

Hours

Lecturers

752-1301-00L

Special Topics in Toxicology

W 2 credits 2G S. J. Sturla, K. Hecht

Abstract

Journal-club style course involving student presentations and active discussion and critique of recent publications and modern experimental strategies. The focus is on chemical, biochemical, and nutritional aspects of selected topics in Toxicology, with a new group of topics addressed each semester.

Objective

- to stimulate student interest and provide advanced knowledge of current research in Toxicology and its related sciences
- to develop skills in critical evaluation of scientific literature, oral presentation and questioning
- to understand modern experimental techniques and research approaches relevant in Toxicology

Content

The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on chemical, biochemical, and nutritional aspects of selected current topics in Toxicology. Participants are masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Biochemistry, Pharmaceutical Sciences, etc.).

Literature

A selection of approximately 20 papers from recent primary scientific literature.

Prerequisites / notice

The course is open to Masters or PhD level students.

For Masters level participants, a strict prerequisite is (a) previously taken and passed "Introduction to Molecular Toxicology" (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission.

If you would like to take "Special Topics in Toxicology", do not register at the same time for "Advanced Topics in Toxicology". It is only possible to take one, and it is only possible to take the advanced level after completing this course.

752-1302-00L

Advanced Topics in Toxicology

W 2 credits 2G S. J. Sturla

Abstract

Journal-club style course that involves student presentations of selected topics in Toxicology on the basis of current primary research and review papers.

Objective

The goals are to stimulate student interest and provide advanced knowledge of current research in the interdisciplinary area of Food and Nutrition Toxicology and its related sciences. The student should develop skills in the critical evaluation of scientific literature, oral presentation and questioning, and understanding modern experimental techniques in Molecular Toxicology.

Content

The journal-club style course involves student presentations of recent publications. The primary focus is on chemical and biochemical aspects of selected topics in Toxicology. Participants are generally masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Pharmaceutical Sciences, etc.), and strong knowledge of organic chemistry and biochemistry are prerequisite. Selected course topics change every semester.

Prerequisites / notice

Participants are required to have completed previously "Special Topics in Toxicology" (752-1301-00L). Both courses are run concurrently every semester. It is only possible to register for one course at a time. Do not register for "Advanced Topics in Toxicology" until after you have completed "Special Topics in Toxicology".

529-0047-00L

Risk Assessment of Chemicals

W 7 credits 6A C. Bogdal, K. Hungerbühler, N. von Götz, Z. Wang

Abstract

Projects on chemical assessment with the focus on the analysis and assessment of basic substance data for selected chemical classes; analysis and modelling of technical processes; characterisation of environmental and health risks. Risk assessment on the basis of quality and protection goals. Estimation of model and parameter uncertainty. Precaution and safety measures.

Objective

Project thesis (report) on chemicals assessment; time frame totals ca. 80 hours.

Content

Projects on chemical assessment with the focus on the following aspects:

- Analysis and assessment of basic substance data for selected chemical classes: physical chemical properties, environmental behaviour (distribution, persistence), human and eco-toxicity (biochemical metabolism, effect mechanisms), safety.
- Analysis and modelling of technical processes determining chemical release into the environment, e.g., chemicals applications.
- Characterisation of environmental and health risks on the basis of exposure and effect models, QSARs from environmental chemistry, toxicology and methods of risk analysis.
- Risk assessment on the basis of quality and safety goals. Estimation of the model and data uncertainty.
- Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

Lecture notes

Project teaching; time frame totals ca. 80 hours.

See recommended literature.
### Literature

### Prerequisites / notice
- Voraussetzung: 529-0580-00L - Rikoanalyse chemischer Prozesse und Produkte oder: 701-0998-00L - Environmental and Human Health Risk Assessment of Chemicals
- Beschränkt auf 6 Projektarbeiten pro Semester

### 752-4009-00L Molecular Biology of Foodborne Pathogens
- **Type**: Hours
- **ECTS**: 3 credits
- **Lecturers**: M. Loessner, M. Schupper

#### Abstract
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

#### Content
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

#### Lecture notes
Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

#### Literature
Lectures will be given in the first lecture

### 752-6105-00L Epidemiology and Prevention
- **Type**: Hours
- **ECTS**: 3 credits
- **Lecturers**: M. Puhan, R. Heusser

#### Information for UZH students:
Enrolment to this course unit only possible at ETH. No enrolment to module CS16_101 at UZH.

#### Abstract
The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.

#### Objective
The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.

#### Content
The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

### Electives

#### 752-0005-00L Public Colloquium in Food Science
- **Type**: Hours
- **ECTS**: 1 credit
- **Lecturers**: S. J. Sturla

#### Abstract
Participation in weekly seminars on a variety of topics including Food Microbiology, Food Toxicology, Food Biochemistry, Food Processing, Consumer Behavior, Food Technology, and Food Materials and Technology, and oral presentation of a selected published study in one of these areas inspired by participation in the seminars.

#### Objective
The objectives are to become familiar with and stimulate interest in leading-edge science related to the research topics of the Institute of Food, Nutrition and Health. Participants attend weekly seminars given by external and internal speakers, and are also required to deliver a presentation on a recent research article inspired by a topic from the semester presentations.

### Master's Thesis

#### 752-0230-00L Master's Thesis
- **Type**: Hours
- **ECTS**: 30 credits
- **Lecturers**: Supervisors

The topic of the thesis and - if they are not Professors of D-HEST - the examiner and the co-examiner have to be approved by the D-HEST Department Conference.

#### Abstract
The Master thesis completes the master programme and is an independent scientific project. Generally, the topic is selected from the specific field of the major. It is supervised by a professor at D-HEST.

#### Objective
The Master Thesis must demonstrate the student's ability to independent, structured and scientific working.

### Course Units for Additional Admission Requirements
The courses below are only available for MSc students with additional admission requirements.

#### 752-1000-AAL Food Chemistry I
- **Type**: Hours
- **ECTS**: 3 credits
- **Lecturers**: L. Nyström, M. Erzinger

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

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Data: 06.11.2018 12:57  Autumn Semester 2016  Page 904 of 1571
Abstract
To familiarise with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

Objective
To familiarise with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

Content
Descriptive chemistry of food constituents (proteins, lipids, carbohydrates, plant phenolics, flavour compounds). Reactions which affect the colour, flavour, texture, and the nutritional value of food raw materials and food products during processing, storage and preparation in a positive or in a negative way (e.g. lipid oxidation, Maillard reaction, enzymatic browning).

Links to food analysis, food processing, and nutrition.

Lecture notes
The lectures are supplemented with handouts.

Literature

752-1101-AAL
Food Analysis I
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
To understand the basic principles of analytical chemistry. To get acquainted with the principles and applications of important routine methods of instrumental food analysis (UV/VIS, IR, AAS, GC, HPLC).

Objective
To understand the basic principles of analytical chemistry. To get acquainted with the principles and applications of important routine methods of instrumental food analysis (UV/VIS, IR, AAS, GC, HPLC).

Content
Methods: Optical spectroscopy (basic principles, UV/VIS, IR, and atomic absorption spectroscopy). Chromatography (GC, HPLC).

Lecture notes
The lectures are supplemented with handouts.

Literature

752-3000-AAL
Food Process Engineering I
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
To procure the students with the basic physics of food process engineering, especially with the mechanical futures of food systems, i.e. basic principles of engineering mechanics, of thermodynamics, fluid dynamics and of dimension analyses for process design and non-Newtonian fluid mechanics.

Objective

Content

Lecture notes
Vorlesungsskriptum (ca. 100 Seiten, 60 Abbildungen) wird vor der ersten Vorlesung und Folien jeweils vor der Vorlesung bereitgestellt.


Prerequisites / notice
Die Vorlesung erfordert während des Semesters wöchentliche Vor-/Nachbereitung. Im Unterricht wird aktive Mitarbeit erwartet.

752-6305-AAL
Physiology and Anatomy I
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Imparts a basic understanding of physiology and anatomy in man, focusing on the interrelations between morphology and function of the human organism. This is fostered by discussing all subjects from a functional point of view. One major topic of the lecture is food intake and digestion with its correlated chemosensory, endocrine and metabolic processes.

Objective
At the end of the course the students understand the basic functions of the organ systems and functionally important morphological features. One focus of the course is on aspects related to nutrition and overweight including the resulting diseases.

752-6306-AAL
Physiology and Anatomy II
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Imparts a basic understanding of physiology and anatomy in man, focusing on the close interrelations between morphology and function of the human organism. This is fostered by discussing all subjects from a functional point of view. A major topic of the lecture is food intake and digestion with its correlated endocrine and metabolic processes.

Objective
After this course the students are able to understand basic principles of systems physiology and the mechanisms of the function of the major organ systems.

752-6001-AAL
Introduction to Nutritional Science
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
This course introduces basic concepts of micro- and macronutrient nutrition. Micronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.
<table>
<thead>
<tr>
<th>Objective</th>
<th>To introduce the students to the both macro- and micronutrients in relation to food and metabolism.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.</td>
</tr>
</tbody>
</table>
| Literature| Elmadfa I & Leitzmann C: Ernährung des Menschen  
UTB Ulmer, Stuttgart, 4. überarb. Ausgabe 2004  
Garrow JS and James WPT: Human Nutrition and Dietetics  
Churchill Livingstone, Edinburgh, 11th rev. ed. 2005  

### 551-0001-AAL General Biology I
**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

<table>
<thead>
<tr>
<th>E- 3 credits</th>
<th>U. Sauer, O. Y. Martin, A. Widmer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Organismic biology to teach the basic principles of classical and molecular genetics, evolutionary biology and phylogeny.</td>
</tr>
<tr>
<td>Objective</td>
<td>The understanding of basic principles of biology (inheritance, evolution and phylogeny) and an overview of the diversity of life.</td>
</tr>
<tr>
<td>Content</td>
<td>The first semester focuses on the organismal biology aspects of genetics, evolution and diversity of life in the Campbell chapters 12-34.</td>
</tr>
<tr>
<td>Week 1-7</td>
<td>by Alex Widmer, Chapters 12-25</td>
</tr>
<tr>
<td>12 Cell biology Mitosis</td>
<td></td>
</tr>
<tr>
<td>13 Genetics Sexual life cycles and meiosis</td>
<td></td>
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<tr>
<td>14 Genetics Mendelian genetics</td>
<td></td>
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<tr>
<td>15 Genetics Linkage and chromosomes</td>
<td></td>
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<tr>
<td>20 Genetics Evolution of genomes</td>
<td></td>
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<tr>
<td>21 Evolution How evolution works</td>
<td></td>
</tr>
<tr>
<td>22 Evolution Phylogenetic reconstructions</td>
<td></td>
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<tr>
<td>23 Evolution Microevolution</td>
<td></td>
</tr>
<tr>
<td>24 Evolution Species and speciation</td>
<td></td>
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<tr>
<td>25 Evolution Macroevolution</td>
<td></td>
</tr>
<tr>
<td>Week 8-14</td>
<td>by Oliver Martin, Chapters 26-34</td>
</tr>
<tr>
<td>26 Diversity of Life Introduction to viruses</td>
<td></td>
</tr>
<tr>
<td>27 Diversity of Life Prokaryotes</td>
<td></td>
</tr>
<tr>
<td>28 Diversity of Life Origin &amp; evolution of eukaryotes</td>
<td></td>
</tr>
<tr>
<td>29 Diversity of Life Nonvascular&amp;seedless vascular plants</td>
<td></td>
</tr>
<tr>
<td>30 Diversity of Life Seed plants</td>
<td></td>
</tr>
<tr>
<td>31 Diversity of Life Introduction to fungi</td>
<td></td>
</tr>
<tr>
<td>32 Diversity of Life Overview of animal diversity</td>
<td></td>
</tr>
<tr>
<td>33 Diversity of Life Introduction to invertebrates</td>
<td></td>
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<tr>
<td>34 Diversity of Life Origin &amp; evolution of vertebrates</td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>No script</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>This is a virtual self-study lecture for non-German speakers of the &quot;Allgemeine Biology I (551-0001-00L) lecture. The exam will be written jointly with the participants of this lecture. Example exam questions will be discussed during the lectures, and old exam questions are kept by the various student organisations. If necessary, please contact Prof. Uwe Sauer (<a href="mailto:sauer@ethz.ch">sauer@ethz.ch</a>) for details regarding the exam.</td>
</tr>
</tbody>
</table>

### 551-0002-AAL General Biology II
**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

<table>
<thead>
<tr>
<th>E- 4 credits</th>
<th>U. Sauer, R. Aebersold, H.M. Fischer, W. Gruissem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Molecular biology approach to teach the basic principles of biochemistry, cell biology, cogenetics, evolutionary biology and form and function of vascular plants.</td>
</tr>
<tr>
<td>Objective</td>
<td>The understanding basic concepts of biology: the hierarchy of the structural levels of biological organisation, with particular emphasis on the cell and its molecular functions, the fundamentals of metabolism and molecular genetics, as well as form and function of vascular plants.</td>
</tr>
<tr>
<td>Content</td>
<td>Week 1-7 by Alex Widmer, Chapters 12-25</td>
</tr>
<tr>
<td>12 Cell biology Mitosis</td>
<td></td>
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<td>13 Genetics Sexual life cycles and meiosis</td>
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<td></td>
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<td>34 Diversity of Life Origin &amp; evolution of vertebrates</td>
<td></td>
</tr>
</tbody>
</table>
Content
The structure and function of biomacromolecules; basics of metabolism; tour of the cell; membrane structure and function; basic energetics of cellular processes; respiration, photosynthesis; cell cycle, from gene to protein; structure and growth of vascular plants, resource acquisition and transport, soil and plant nutrition.

Specifically the following Campbell chapters will be covered:
3   Biochemistry   Chemistry of water
4   Biochemistry   Carbon: the basis of molecular diversity
5   Biochemistry   Biological macromolecules and lipids
7   Cell biology   Cell structure and function
8   Cell biology   Cell membranes
10  Cell biology   Respiration: introduction to metabolism
10  Cell biology   Cell respiration
11  Cell biology   Photosynthetic processes
16  Genetics   Nucleic acids and inheritance
17  Genetics   Expression of genes
18  Genetics   Control of gene expression
19  Genetics   DNA Technology
35  Plant structure & function   Plant Structure and Growth
36  Plant structure & function   Transport in vascular plants
37  Plant structure & function   Plant nutrition
38  Plant structure & function   Reproduction of flowering plants
39  Plant structure & function   Plants signal and behavior

Lecture notes
No script

Literature

Prerequisites / notice
PLEASE NOTE This lecture is newly conceived and will be held for the first time in the spring semester 2017.

406-0063-AAL  Physics II
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
Introduction to the "way of thinking" and the methodology in Physics. The Chapters treated are Magnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena.

Objective
Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.

The student should acquire an overview over the basic concepts used in the theory of heat and electricity.

Content
Book:

Chapters:

Literature
see "Content"

Friedhelm Kuypers
Physik für Ingenieure und Naturwissenschaftler
Band 2 Elektrizität, Optik, Wellen
Verlag Wiley-VCH, 2003, Fr. 77.-

406-0063-AAL  Stochastics (Probability and Statistics)
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content
From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student's t Distribution
Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation
**Literature**

- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  From within the ETH, this book is freely available online under: [http://www.springerlink.com/content/m17578/](http://www.springerlink.com/content/m17578/)

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**Food Science Master - Key for Type**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Architecture and Digital Fabrication

Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>065-0061-00L</td>
<td>MAS in Architecture and Digital Fabrication</td>
<td>E-</td>
<td>0</td>
<td>7K</td>
<td>F. Gramazio, M. Kohler</td>
</tr>
</tbody>
</table>

Abstract

The MAS ETH in Architecture and Digital Fabrication is an interdisciplinary education programme initiated by the National Centre of Competence in Research (NCCR) Digital Fabrication and the ETH Zurich. The focus lies upon the methods and techniques of digital design and fabrication and their significance for future building culture.

Objective

The NCCR Digital Fabrication is an ambitious initiative that brings together leading researchers in the disciplines of architecture, engineering, robotics, material and computer sciences. As the main education platform for this NCCR, the MAS ETH in Architecture and Digital Fabrication will benefit from direct exchange with its investigators and immediate access to cutting edge research and innovation. In the NCCR's unique robotic fabrication facilities, the students will also have the opportunity to research digital design and construction processes, and to implement these directly in large-scale prototypes.

The MAS ETH in Architecture and Digital Fabrication is conceived as a 12 months full-time programme targeted at university graduates with excellent design skills and technical knowledge. The teaching language of the programme will be English. The programme begins on the 14th of September 2015. Applications will be accepted until the 30th of April 2015.

Participants will develop competence in complex design and production challenges and will be able to take leading positions in the field of architecture, construction, or the extended design and production industries.

Content

The MAS Digital Fabrication is a 1 year full-time programme and is structured as a series of teaching modules with an independent master thesis. Lessons within the modules are given in the form of lectures, practical workshops, and projects as the main modus for developing skills. Learning will be supported through one on one mentoring in studio, group critiques, symposia, and excursions.

Prerequisites / Notice

A Master's degree in architecture or engineering acknowledged by ETH, or equivalent educational qualifications (i.e. a bachelor's degree and a minimum of two years professional experience in a directly related field). Additional critical requirements are proof of creative design skills and technological capabilities. Qualification will be assessed from application documents and skills will be evaluated through portfolio review.

Special students and auditors need special permission from the lecturers.

ECTS European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
MAS in Architecture and Information

The studies take one full year and begin in the autumn semester.

The programme contains 75 CP and is divided into about 6-8 modules of 3-4 weeks, which are taught in seminars that are each concluded with an individual or group project. The studies end with an individual thesis.

For more information about the modules please visit: http://www.caad.arch.ethz.ch/

Teaching languages are English and German. The number of participants is 6 to 12.

Courses Offered

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<td>065-0069-07L</td>
<td>MAS ETH in Architecture and Information</td>
<td>E-</td>
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<td>6K</td>
<td>L. Hovestadt</td>
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Abstract

After successful completion the students achieve 70 Creditpoints.

Objective

A fundamental theoretical and practical introduction to the application of information technologies in architecture. The MAS program CAAD is a yearly full time program, consisting of eight 4-weekly instruction modules with practical exercises and a concluding individual Masterthesis.

Development of new design methods, new construction forms, media architectures, narrative infrastructures, global models. Parametric and generative CAD systems, procedural, object-oriented and agent-based programming, introduction to JAVA/Processing, introduction to diverse computer-controlled machines with practical examples, development of machine-compatible building constructions, development of electronics for automated tasks, implementation of radio networks.

Content

http://www.mas.caad.arch.ethz.ch/

Lecture notes

http://www.mas.caad.arch.ethz.ch/

Literature

http://www.mas.caad.arch.ethz.ch/

MAS in Architecture and Information - Key for Type

O  Compulsory
W+  Eligible for credits and recommended
W  Eligible for credits
E-  Recommended, not eligible for credits
Z  Courses outside the curriculum
Dr  Suitable for doctorate

Key for Hours

V  lecture
G  lecture with exercise
U  exercise
S  seminar
K  colloquium
P  practical/laboratory course
A  independent project
D  diploma thesis
R  revision course / private study

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Compulsory Courses

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<td>4G</td>
<td>M.L. Müller</td>
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<td>discuss their importance for development</td>
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<td>- explain different conceptions of development</td>
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<td>- analyse the evolution of the International</td>
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<td>- describe the Swiss landscape of actors in</td>
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<td>into the international community of donors.</td>
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<td>assess possible implications of the Agenda</td>
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<td>and empirical discussions on economic</td>
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<td>developing countries over the last 50 years.</td>
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<td>F. Brugger</td>
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<td>and on possible interventions of development</td>
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<td>- describe the current status and threats of</td>
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<td>in different contexts and discuss the key</td>
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<td>challenges in each sector.</td>
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<td>- examine the implications of climate change</td>
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<td>- analyze conflicts and trade-offs between</td>
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<td>- discuss the global priorities relating to</td>
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<td>human-induced changes to the environment, and</td>
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### Electives

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<td>F. Brugger, R. Batliner</td>
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Abstract
This course discusses ethical questions of development relevant for international cooperation. Examples include: possibilities and limits of normative justification of development aid; theories of justice, human rights and the 'rights-based' approach to development; epistemological foundations of development theories, ethical questions of globalization.

Objective
What is justice and why are human rights valid? What is development and what is the responsibility of the State? The answers always include normative judgements. Where these normative dimensions remain implicit, international development cooperation risks the unreflected export of its own value and belief systems. This course enables students to identify implicit normative dimensions, put them into the ethical context and to critically reflect on those normative aspects.

Sanitation and Water Supply in Development
2 credits
3G
M.L. Müller, C. Zurbrügg

Abstract
The course provides an overview of the links among sanitation, water supply, waste management and environmental and health aspects. It gives an understanding of the specific challenges and possible solutions in ensuring environmental services and illustrates their impact on the population and settlements.

Objective
The participants are able to:
- present the global situation and development trends in the sector of sanitation, water supply, waste management and for its main actors;
- discuss the relationships between water supply, sanitation and health;
- explain the principles of technologies for drinking water treatment, the management of sewage and waste, as well as appraise their strengths and weaknesses;
- explain which sustainable concepts are implemented and how they can be inserted into the technical, institutional and social structures so that they are economically, ecologically and socially sustainable;
- provide information where good professional resources are available.

Food Security and Agriculture
2 credits
3G
L. B. Nilsen

Abstract
Food security has been on top of the policy agenda for decades, but still a considerable proportion of the population in developing countries remains hungry and malnourished. This lecture series will explore how we produce and distribute food; analyse the concept of food security and discuss ways and means for increasing the availability and accessibility of food in developing countries.

Objective
The student will be able to:
- describe the most important milestones in the history of food and agriculture
- understand the concept of food security and discuss causes and impacts of food insecurity
- compare different approaches to promote and increase crop- and livestock production in a sustainable manner
- reflect on some of the main economic challenges of the world food system and understand some of the tradeoffs between smallholders' decisions of labor, consumption, and production of food
- give insights in how international organizations work with farmers and governments in developing countries to ensure availability and equal access to food

Applied Statistics and Policy Evaluation
3 credits
3G
I. Günther, K. Harttgen

Abstract
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical software Stata.

Objective
Students are able to:
- have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software STATA for data analysis

Content
The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials methodology used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.

Foundations of Sustainable Development Practice
1 credit
1G
D. Molnar, R. Batliner

Abstract
The course provides students with an introduction to concepts of sustainable development, with an emphasis on the Sustainable Development Goals (SDGs). Both conceptual and practical issues are presented, with the intention of challenging students to critically assess and debate on issues of current global development.

Objective
The students are able to:
- define the main underlying concepts of the SDGs like "sustainability" and "development";
- explain the background of the Agenda 2030, its intention, the process of its development and the guiding principles for its implementation;
- discuss practical difficulties in pursuing and achieving sustainable development through development & cooperation interventions;
- describe the relevant actors and their roles and responsibilities;
- discuss the merits and the limitations of such an ambitious, multi-disciplinary, universally agreed upon framework;
- examine what the SDGs could mean for "developed nations" like Switzerland;
- compare different approaches to promote and increase crop- and livestock production in a sustainable manner

Content
- Setting the stage: What is sustainable? What is development? Why Sustainable Development Goals (SDGs)?
- The Agenda 2030: 17 goals and 169 targets
- Actors: Who are the actors in the SDG debate? How do these actors influence decisions? What are the roles of civil society, of the private sector, and of governments in implementing the SDGs?
- Switzerland: What does the Agenda 2030 mean for Switzerland's national and international agendas? Which SDGs does Switzerland focus on at home and abroad?
- Focus on a selection of SDGs and their related targets (not dealt with in other courses).

Health and Development - Health Related Aspects of
2 credits
2G
M.L. Müller, N. D. Labhardt
International Development Aid
Only for MAS in Development and Cooperation.

Abstract
The following topics will be discussed: Basic principles of epidemiology and global burden of disease distribution, Health systems and health system strengthening including economic aspects and health insurance, communicable diseases such as HIV/AIDS, Malaria, tuberculosis and neglected tropical diseases, mother and child health, non-communicable diseases and transition in health in LAMICs.

Objective
This course aims at providing a public health driven overview on most important topics related to health and health care in low- and middle-income countries (LAMICs). After the module participants shall have broad understanding of challenges for health, health care and health systems in LAMICs. They shall be able to discuss more in depth some major global health topics, such as health systems, transition in health, malaria, neglected tropical diseases and HIV/AIDS. The course will provide an insight into current strategies and approaches addressing major global health topics.

Semester Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>Semester Thesis</td>
<td>O</td>
<td>4 credits</td>
<td>9A</td>
<td>Lecturers</td>
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Only for MAS in Development and Cooperation.

No direct enrolment to this course unit in myStudies. For registration, please contact the Administration MAS Development and Cooperation directly.

MAS in Development and Cooperation - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

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<tr>
<td>V</td>
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<td>G</td>
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<td>U</td>
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<td>S</td>
<td>seminar</td>
<td>R</td>
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<td>K</td>
<td>colloquium</td>
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ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Nutrition and Health

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>752-6402-00L</td>
<td>Nutrigenomics</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>G. Vergères</td>
</tr>
<tr>
<td>Abstract</td>
<td>Nutrigenomics - toward personalized nutrition? Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.</td>
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<tr>
<td>Objective</td>
<td>- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics. - Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics. - Ability to critically evaluate the potential and risks associated with the field of nutrigenomics</td>
<td></td>
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<tr>
<td>Content</td>
<td>- For the content of the script see section &quot;Skript&quot; below. - The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.</td>
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<tr>
<td>Lecture notes</td>
<td>The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules</td>
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</tr>
<tr>
<td>Literature</td>
<td>Module A From biochemical nutrition research to nutrigenomics Module B Nutritional genomics Module C Nutrigenetics Module D Nutri-epigenomics Module E Transcriptomics in nutrition research Module F Proteomics in nutrition research Module G Metabolomics in nutrition research Module H Nutritional systems biology</td>
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<tr>
<td>Prerequisites / notice</td>
<td>No extra reading requested. Most slides in the lecture are referenced with web addresses.</td>
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<tr>
<td>752-6105-00L</td>
<td>Epidemiology and Prevention</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Puhan, R. Heusser</td>
</tr>
<tr>
<td>Abstract</td>
<td>Information for UZH students: Enrolment to this course unit only possible at ETH. No enrolment to module CS16_101 at UZH. Please mind the ETH enrolment deadlines for UZH students: <a href="https://www.ethz.ch/en/studies/non-degree-courses/special-students-special-students-university-of-zurich.html">https://www.ethz.ch/en/studies/non-degree-courses/special-students-special-students-university-of-zurich.html</a></td>
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<tr>
<td>Objective</td>
<td>The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.</td>
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<tr>
<td>Content</td>
<td>The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware of how epidemiological facts are used in prevention, practice and politics.</td>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>752-2307-00L</td>
<td>Nutritional Aspects of Food Composition and Processing</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>B. E. Baumer, J. M. Sych</td>
</tr>
<tr>
<td>Abstract</td>
<td>Lecture type course with an interdisciplinary approach for the evaluation of nutritional aspects of changes in food composition due to processing.</td>
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<tr>
<td>Objective</td>
<td>Students should be able to - describe and compare the major concepts /criteria used for the evaluation of the nutritional quality of food - apply these criteria when assessing the effects of selected processing technologies on nutritional quality. - evaluate recent formulation strategies aimed to achieve additional physiological benefits for targeted population groups (i.e. functional foods).</td>
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<tr>
<td>Content</td>
<td>The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g. nutritional profile) will be addressed.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing.</td>
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Data: 06.11.2018 12:57  Autumn Semester 2016  Page 914 of 1571
Food Law and Legislation
Documents about Codex Alimentarius, the EU as well as the Swiss food law and some regulations will be handed out.

Food and Consumer Behaviour
Learning analytical methods to determine macro- and micronutrient content in foods. Critical evaluation of analytical results, critical comparison with values from food composition tables, and interpretation in relation to nutritional value of meals.

Lecture notes
Handouts for each lecture will be made available every week: http://www.fpb.ethz.ch/teaching/handouts.html

752-2122-00L Food and Consumer Behaviour W 2 credits 2V M. Siegrist, C. Hartmann
Abstract
This course focuses on food consumer behavior, consumer’s decision-making processes and consumer’s attitudes towards food products.

Objective
The course provides an overview about the following topics: Factors influencing consumer’s food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

752-0801-00L Food Law and Legislation W 1 credit 1V C. Spinner, E. Zbinden Kaessner
Abstract
Principles of the Swiss food law, introduction to the principles of the EU, international organisations and international contracts.

Objective
Overview about the general principles, institutions and execution of the Swiss food law as well as a presentation of the most important regulations of the Swiss food legislation. Knowledge about the principles and the structure of the EU in general and in the area of food safety, overview on the bilateral agreements CH-EU as well as on the most important international organisations (Codex Alimentarius and WTO) and their influence on the Swiss regulations on food safety.

Prerequisites / notice
Copies of the presentations will be handed out.

Language: English
It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

Electives

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>752-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W+</td>
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<tr>
<td></td>
<td><strong>Number of participants limited to 20.</strong> Permission from lecturers required for all students.</td>
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<tr>
<td>752-0801-00L</td>
<td>Food Law and Legislation</td>
<td>W+</td>
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<tr>
<td></td>
<td><strong>Prerequisites:</strong> General knowledge about Codex Alimentarius, the EU as well as the Swiss food law and some regulations will be handed out. Qualifications: General knowledge of the food sciences. The lecture will be held in German.</td>
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</table>

Autumn Semester 2016
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products. This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. - Kuby, Immunology, 7th edition, Freeman + Co., New York, 2009

Students will be required to complete a group project on food products and ingredients with or from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Probiotics

This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Introduction into structural and functional aspects of the immune system.
- Basic knowledge of the mechanisms and the regulation of an immune response.
- Vaccines, immune-therapeutic interventions
- Hypersensitivities
- Allergies
- Th1 and Th2 cells, regulatory T cells
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

- Public Health Concepts
- The module "public health concepts" offers an introduction to key principles of public health. Students learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

- Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

- Public Health Concepts
- The module "public health concepts" offers an introduction to key principles of public health. Students learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

- Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

- Language of the course is English

Data: 06.11.2018 12:57
Autumn Semester 2016
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► Master’s Thesis
<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
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<th>Hours</th>
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<td>766-6500-00L</td>
<td>MAS Master's Thesis</td>
<td>O 20 credits 43D</td>
<td>Lecturers</td>
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**Abstract**
The study program is completed with the Master thesis, an independent scientific work. Topics are selected within the domains of the MAS program. The work is supervised by a lecturer of the MAS program.

**Objective**
The Master thesis must demonstrate the student's ability to independent, structured and scientific working.

### MAS in Nutrition and Health - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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</table>

### Key for Hours

| V | lecture |
| G | lecture with exercise |
| U | exercise |
| S | seminar |
| K | colloquium |
| P | practical/laboratory course |
| A | independent project |
| D | diploma thesis |
| R | revision course / private study |

**ECTS** European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
MAS in Building Process Leadership

Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>065-0013-00L</td>
<td>MAS-Programme “Building Process Leadership”</td>
<td>E-</td>
<td>0</td>
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<td>A. Paulus</td>
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</table>

Abstract
The MAS program “Competency in the Building Process” provides graduates of the program with a thorough understanding of the complexities of a project, instilling them with an increased capacity to assess the consequences of their actions and decisions. Upon successful completion of the studies, graduates are qualified to assume the complex duties of an overall project leader in building projects.

Objective
Over the course of the MAS program, students review and closely examine professional experiences gained so far. The goal of the program is to develop an understanding and form opinions on the present-day building process. The course directs students to draw independent conclusions and set forecasts for design professionals in the building process, creating a basis, in conjunction with group discussions, for independent study.

Content
The Master of Advanced Studies in «Competency in the Building Process» imparts an integral view of the building process. Ever-changing technical and social demands, complex permit processes and increasing pressure to speed up production and completion times have led to the fragmentation and specialization of services and work performed by building process participants. Maintaining an overview of the project are the architects and engineers, who draw from a broad knowledge base as they direct, coordinate and moderate all disciplines involved in the design and construction process.

The MAS program «Competency in the Building Process» is a part-time study for professionally experienced architects and engineers. It provides graduates of the program with a thorough understanding of the complexities of a project, instilling them with an increased capacity to assess the consequences of their actions and decisions. Upon successful completion of the studies, graduates are qualified to assume the complex duties of an overall project leader in building projects.

Over the course of the MAS program, students review and closely examine professional experiences gained so far. The goal of the program is to develop an understanding and form opinions on the present-day building process. The course directs students to draw independent conclusions and set forecasts for design professionals in the building process, creating a basis, in conjunction with group discussions, for independent study.

Literature
Literatureempfehlungen unter www.bauprozess.arch.ethz.ch
Sacha Menz (Hrsg.), Drei Bücher über den Bauprozess, vdf Hochschulverlag an der ETH Zürich, 2009

MAS in Building Process Leadership - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

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<tr>
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<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The MAS-programm in "History and Theory of Architecture" is a two-year half-time course and contains 60 CP. The course starts in the autumn semester.

Attendance of classes supplemented by independent research; practical training periods and excursions; lectures/seminars on one to two days per week, in total 600 ca. contact hours, in addition private study ca. 600 hours (for each in-class day one day of work preparation), two individually tutored seminar papers on chosen subjects (200 hours) and credited Master's thesis (600 hours).

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</table>

**Abstract**
The program aims at enhancing students’ understanding of subject matter and methods in the field of research into architectural theory and at assisting them in the critical investigation of the history and theory of architecture.

**Objective**
The historical and social roots of architecture are an essential aspect of the work of architects. To adapt the past to one’s own thinking and knowledge, is a challenge. This will be done in a lively and reflecting process. Anyone faced with this challenge in the practical work will find a quality for his buildings that can’t be reached by only considering urbanistic, aesthetic and functional factors. Based on selected issues, the participants of the MAS-program “Geschichte und Theorie der Architektur” get acquainted with the methods of historic research. Participants will gain a deeper insight into the subjects and methods of architectural historians and will be supported in scientific discourses.

**Content**
The MAS-program “Geschichte und Theorie der Architektur” includes a weekly four-hour seminar in which the techniques of scientific work (methodology, creating a bibliography, researching, textual criticism, editing) and practicing essential aspects of art and architecture are discussed on the basis of texts and buildings before they are written down in textual form. Historiographical and methodological aspects as well as training in analyzing and describing architectural phenomena are at the forefront. A major concern is also to improve the ability for writing of texts (encyclopedia articles, short essays, project descriptions, academic papers). Writing is a key instrument not only of disciplinary discourse, but also the public exchange of research. Depending on the topic of the course, there is a single or multi-day trip, during which the participants talk about the buildings that are visited. In addition, each semester, at least two additional courses of the Institute gta have to be visited.

The course concludes with a diploma thesis written on a subject that is chosen by the students. The concept and writing of this work are intended to be a process that evolves continuously while studying. The thesis can be extended into a dissertation, provided the student has a graduate degree that is acknowledged by the ETH.
MAS in Housing

The course offered within the MAS-program "Housing" is classified in four relevant modules:

- Module 1: social and historical context of housing, housing design and construction.
- Module 2: Housing design, past and present: Typology: building, biography of usage.
- Module 3: Housing as a contribution of urban design and neighborhood development.
- Module 4: Sustainable development - a new goal in housing design and construction.

Also see separate program.

The attendance of the lecture "Housing" of Prof. Eberle in the autumn semester is compulsory. Individual chosen 3-4 further lectures or seminars in the Autumn or Spring Semester have to be attended (6 CP).

The modules 3 and 4 are offered in the Spring Semester.

Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>065-0059-00L</td>
<td>MAS-Programme &quot;Housing&quot;</td>
<td>E-</td>
<td>0</td>
<td>8K</td>
<td>M. A. Glaser</td>
</tr>
</tbody>
</table>

Abstract

Relevant issues about the provision, the design and the construction of housing and quality of living are explored based on an interdisciplinary analysis. The MAS thesis is focused on studying, for example, the interdependence of architectural, social, spacial and urban planning considerations, and shifting demand and usage patterns related to housing.

Objective

Against the backdrop of jointly developed theoretical ideas, the students job-related skills and accomplishments in the fields of drawing up concepts, analysis, interpretation, and conversion as well in oral and written conveying are consolidated and expanded in discussions and in joint work. The course of study does not strive to train generalists. Instead it deals with the formulation of questions and procedures elaborated by the students in a generalistic or interdisciplinary way. This is the decisive factor in the qualitative added value of methods which span over several disciplines.

Content

Relevant issues about the provision, the design and the construction of housing and quality of living are explored based on an interdisciplinary analysis. The MAS thesis is focused on studying, for example, the interdependence of architectural, social, spacial and urban planning considerations, and shifting demand and usage patterns related to housing.

MAS in Housing - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
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</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
</tbody>
</table>

Key for Hours

| V      | lecture |
| G      | lecture with exercise |
| U      | exercise |
| S      | seminar |
| K      | colloquium |
| P      | practical/laboratory course |
| A      | independent project |
| D      | diploma thesis |
| R      | revision course / private study |

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Landscape Architecture

The Master of Advanced Studies in Landscape Architecture is a one-year full time postgraduate diploma programme delivered in English. It deals mainly with a scale of landscape that is between that of project design and landscape planning. The focus is on peripheral landscapes and their integration into our cities. In the context of the MAS LA these are discussed and developed in respect to their contemporary functional, ecological and aesthetic potentials. Language: English, contact hours: 600h.

For further information please visit: http://www.girot.arch.ethz.ch/

Courses Offered

The programme is a one-year full time master programme, structured around two main poles: a landscape design studio (laboratory), and a theory seminar (oratory). Emphasis within the programme on Landscape Video will also help provide a strong analytical basis in both theory and design. The studies are held during the semester from Tuesday to Friday. The programme will conclude with an individual thesis work.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>065-0063-00L</td>
<td>MAS-Programme &quot;Landscape Architecture&quot;</td>
<td>E-</td>
<td>0 credits</td>
<td>16K</td>
<td>C. Girot</td>
</tr>
</tbody>
</table>

Abstract

Within the "Master of Advanced Studies in Landscape Architecture" (MAS LA), the use of the latest modeling and visualization possibilities as well as the actual 3D depiction of landscape architecture make up the core emphasis. Here, the focus lies on the integration of CAD/CAM technologies as a design-supporting medium.

Objective

Through an intensive investigation of the latest software and techniques, the students are capable of the following:
- Represent complex design tasks
- Develop spatial perception at different levels of scales
- Handle current problems efficiently and experimentally
- Develop new visualization and communication techniques using new media
- Communicate design ideas professionally

Content

The MAS LA is a one-year (academic) postgraduate diploma programme delivered in English. It's divided into themed modules and a concluding synthesis module. The chosen CAD programs (i.e. Rhino) are particularly appropriate for the visualization of large-scale landscape designs and offer the possibility for export to computer-steered milling machines. In addition, superior competency enhancement in the area of 3D GIS and the use of photography as a design tool and video as tool for illustration and design round off the goal-oriented program.

MAS in Landscape Architecture - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Introduction to Management and Human Resource Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0301-00L</td>
<td>Work Design and Organizational Change</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>G. Grote</td>
</tr>
</tbody>
</table>

**Abstract**
Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.

**Objective**
- Know effects of work design on competence, motivation, and well-being
- Understand links between design of individual jobs and work processes
- Know basic processes involved in systematic organizational change
- Understand the interaction between organization and technology and its impact on organizational change
- Understand relevance of work design for company performance and strategy
- Know and apply methods for analyzing and designing work

**Content**
- Work design: From Adam Smith to job crafting
- Effects of work design on performance and well-being
- Approaches to analyzing and designing work
- Modes of organizational change and change methods
- Balancing stability and flexibility in organizations as design criterion
- The organization-technology interaction and its impact on work design and organizational change
- Example Flexible working arrangements
- Strategic choices for work design

**Literature**
A list of required readings will be provided at the beginning of the course.

**Prerequisites / notice**
The course includes the completion of a course project to be conducted in groups of four students. The project entails applying a particular method for analyzing and designing work processes and is carried out by means of interviews and observations in companies chosen by the students.

**Introduction to Management**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0341-00L</td>
<td>Introduction to Management</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Brusoni, P. Baschera</td>
</tr>
</tbody>
</table>

**Abstract**
This course is an introduction to the critical management skills involved in planning, structuring, controlling and leading an organization.

**Objective**
We develop a 'systemic' view of organizations.
We look at organizations as part of an industry context, which is affected by different elements like strategy, structure, culture, tasks, people and outputs.
We consider how managerial decisions are made in any one of these domains affect decisions in each of the others.

**Content**
Further information is available on the Tim Group Chair's website:
http://www.timgroup.ethz.ch/en/courses

and on the Moodle of the course:
https://moodle-app2.let.ethz.ch/course/view.php?id=2209
(The Enrollment Key to Moodle will be provided during the course)

**Lecture notes**
The content of the course will rely on the book:

Selected readings from the book and additional learning materials will be available on the course Moodle:
https://moodle-app2.let.ethz.ch/course/view.php?id=2209

All the materials uploaded on Moodle must be considered as required readings.

**Prerequisites / notice**
The final exam of the present course is in written form.
The final exam is requested for all types of students (BSc, MSc, MAs, PhD, and Exchange students).
It is not possible to retake the exam within the same term or academic year.

We strongly recommend Exchange students to take it into consideration when selecting the courses to attend.

Strategy, Technology and Innovation Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-0403-00L</td>
<td>Introduction to Marketing</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>F. von Wangenheim</td>
</tr>
</tbody>
</table>

**Abstract**
The course is designed to convey a profound understanding of marketing's role in modern firms, its interactions and interfaces with other disciplines, its main instruments and recent trends. Particular attention is given to emerging marketing concepts and instruments, and the role of marketing in technology firms.

**Objective**
After taking the lecture, students should have knowledge on
1) The definition and role of marketing (marketing basics)
2) Creating marketing insights - understanding customer behavior
   - Theoretical concepts in customer behavior (customer behavior)
   - Analytical means to extend knowledge on customer behavior (marketing research)
   - Strategic tools to quantify customer behavior (OLV, CE)
3) Strategic marketing - translating marketing insights into actionable marketing strategies
   - Segmentation, Targeting, and Positioning
   - Attracting customers (marketing mix, 4Ps)
   - Maintaining profitable customer relations (CRM)

**Content**
The course is designed to convey a profound understanding of marketing's role in modern firms, its interactions and interfaces with other disciplines, its main instruments and recent trends. Particular attention is given to emerging marketing concepts and instruments, and the role of marketing in technology firms.

The lecture features a short tutorial that is held at irregularly spaced intervals throughout the semester (approximately every third week). The tutorial is embedded within the lecture and consists of short sessions of about 30 minutes. It serves to illustrate theoretical and methodological concepts from the lecture by walking students through the analysis of real-world data from the telecommunications industry. The case data will be provided so that students practice and apply the concepts of the lecture on their own. The tutorial is held jointly by two Teaching Assistants (Zhiying Cui and Jana Gross) and the professor (Prof. F. v. Wangenheim).
Information Management, Operations Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-0445-00L</td>
<td>Production and Operations Management</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>T. Netland, P. Schönsleben</td>
</tr>
</tbody>
</table>

Abstract
This core course on Production and Operations Management provides the students insights into the basic theories, principles, concepts, and techniques used to design, analyze, and improve the operational capabilities of an organization.

Objective
Students learn why and how operations can be a competitive weapon; how to design, plan, control, and manage production and service processes; how to improve effectiveness and efficiency in operations; how to take advantage of new technological advancements; and how environmental and social concerns affect decisions in global production networks.

Content
The course covers the most fundamental strategic and tactical concepts in production and operations management. The lectures cover:
- Introduction to POM
- Operations strategy
- Capacity management
- Production planning and control
- Production philosophies
- Lean management
- Performance measurement
- Problem solving
- Service operations
- New technologies in POM
- Servitization
- Global production
- Triple-bottom line

Literature

Mastering Digital Business Models

363-0421-00L

Number of participants limited to 100

Abstract
This lecture provides a theory- and practice-based understanding of how today’s information technologies enable new digital business models and disrupt existing markets.

Objective
A. After the lecture, the student is able to evaluate digital business models from different angels, including theory-based views:
- Definition and classification of business models
- Digital business model patterns
- Theoretical frameworks that explain why and how digital business models function
- Impact of digital business model patterns on P&L and balance sheet

- a decision maker in an established company (should I invest in project A or B?)
- an entrepreneur (should I pursue this venture?)
- an investor (should I invest in start-up xy?)

B. The student knows different tools to design digital business model patterns.

Content
Uber, Airbnb, Nest and Jawbone - A wide range of innovative companies exist, which successfully implemented ICT enabled business models and continue to grow at a rapid pace. Examples, illustrating how digitalization, including the "Internet of Things" currently fosters business model innovation across various industries. This course is designed to help students to understand and critically assess such newly emerging (digital) business models.

For the lecture students will get access to one of the leading online teaching platforms (called edX) also offered by other top universities (incl. MIT, Harvard, Berkeley, etc.). Using the edX platform, will allow students to collaborate in online discussions, solve online exercises and present a short educational video as part of a group project.

Key Topics:
- Business model innovation;
- (digital) business model patterns;
- business value of IT;
- the concept of integration;
- transaction cost perspective;
- network economics perspective;
- essentials and impact of web 2.0, internet of things, mobile computing, market places, social analytics and big data;
- IT governance and portfolio management;
- entrepreneurship in the digital space, etc.

Quantitative and Qualitative Methods

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>W+</td>
<td>3</td>
<td>3G</td>
<td>F. Schweitzer, G. Casiraghi, V. Nanumyan</td>
</tr>
</tbody>
</table>

Abstract
Finding solutions: what is complexity, problem solving cycle.

Implementing solutions: project management, critical path method, quality control feedback loop.

Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption

Objective
A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics
The learning objectives of the course are:

1. Students must be able to discuss basic principles, problems and approaches in microeconomics. (2) Students can analyse and explain simple economic principles in a market using supply and demand graphs. (3) Students can contrast different market structures and describe firm and consumer behaviour. (4) Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole. (5) Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.

Lecture notes

Lecture notes and exercises are provided as handouts including notes and literature sources - registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

Prerequisites / notice

Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

### Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0565-00L</td>
<td>Principles of Macroeconomics</td>
<td>W+</td>
<td>3</td>
<td>2</td>
<td>J.E. Sturm</td>
</tr>
</tbody>
</table>

#### Content

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?

#### Objective

This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to every-day economic problems.

#### Abstract

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

#### Literature

The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2467) contains announcements, course information and lecture slides.

We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

### Financial Management

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0711-00L</td>
<td>Accounting for Managers</td>
<td>W+</td>
<td>3</td>
<td>2</td>
<td>M. Passardi</td>
</tr>
</tbody>
</table>

#### Abstract

This course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:

1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematical understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

#### Literature

For students taking only the course 'Principles of Macroeconomics' there is a shorter version of the same book:


The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

Complementary:


#### Exercise

Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.
Abstract
Overview of financial and managerial accounting
Accounting for current and fixed assets
Liabilities and owners equity
Recording change in balance sheet
Measuring financial performance
Managing financial reporting
Full and variable costing system
Using accounting information for decision making purposes

Objective
Understand the different procedures involved in the accounting system
Record change in financial position
Prepare final accounts
Understand the principles of cost accounting
Calculate the different product costs
Make decisions about the acceptance or rejection of a particular product

Content
Financial Accounting: Balance sheet, income statement, double-entry accounting, journal and ledger, accounting for merchandising activities, value-added tax, adjustments before final accounts, provisions, depreciation, valuation,
Managerial Accounting: Full costing, variable costing, cost-volume profit, break-even analysis, activity-based costing

Prerequisites / notice
This course is a prerequisite for the course Financial Management.
Corporate Sustainability

W+ 3 credits 2G V. Hoffmann

Abstract
The lectures addresses the assessment of corporate sustainability and its links to strategy, technology, and finance. Students learn why sustainability matters for managers and how businesses can act towards it. E-modules allow students to train critical thinking skills. In the 2nd half of the semester, sustainability challenges on water, energy, mobility, and food are explored in group projects.

Objective
Understand the limits and the potential of corporate sustainability for sustainable development

Develop critical thinking skills (argumentation, communication, evaluative judgment) that are useful in the context of corporate sustainability using an innovative writing and peer review method.

Be able to recognize and realize opportunities for corporate sustainability in a business environment

Content
Overview of the key concepts of corporate sustainability and topics related to Water, Energy, Mobility, and Food

Business implications of sustainable development, in particular for the assessment of sustainability performance, strategic change towards sustainability, technological innovations and sustainability, and finance and corporate sustainability.

Critical thinking skills for corporate sustainability.

In-depth case studies of corporate sustainability challenges in the track phase: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze technological innovations for sustainability? How to invest money in a sustainable way?

Lecture notes
Presentation slides will be made available on moodle prior to lectures.

Literature
Literature recommendations will be distributed during the lecture

Information Management, Operations Management

Number Title Type ECTS Hours Lecturers
363-0425-00L Transformation: Corporate Development and IT W+ 3 credits 2G T. Gutzwiller

Abstract
The lecture treats the main challenges of business transformation and the alignment of corporate development and IT activities. It presents a holistic approach to business transformation projects by introducing an integrated model dealing with three main design areas "strategy," "processes" and "information systems" and applying this model to various case studies.

Objective
The goal of the lecture is to understand the main challenges of corporate transformation and to demonstrate the application of a holistic project procedure model for corporate transformation projects with special emphasis on the implementation of business and IT.

The student should understand and be able to explain

the main reasons for corporate transformation,
the relevant management processes to manage corporate transformation,
the interdependencies between strategy, processes and information systems, especially how this three levels interrelate,
the critical success factors for the successful accomplishment of large scale corporate transformation projects,
the main instruments of project, quality and change management and
the different types of resulting IT projects.

Content
The globalization of the world leads to an increasingly faster pace in business transformation. Enterprises have to adapt faster and even faster to the environmental changes in a global economy to remain competitive and to make sure they stay in business. In today's information age this does not only mean to adapt business strategy and business processes but also to adapt information systems to the new circumstances. The fast adaptation through large scale corporate transformation projects that change strategy, business processes and information systems is critical to ensure competitiveness for tomorrow. The introduction of new business processes and information systems typically takes years in very complex large scale projects. Many projects fail because of insufficient alignment between decision makers in business and IT. Unclear understanding of the overall project scope, undefined roles and responsibilities, unclear project processes, quality problems and resistance to change are some typical problems found in such projects. The lecture is subdivided into following modules:

Corporate development introduction and motivation,
Parallelization of corporate development and complexity reduction,
Planning process and project portfolio management in corporate development,
Management of large scale projects integration of strategy, processes and information systems,
Quality management in large scale projects,
Project management in large scale projects,
Change management within projects. The lecture is accompanied by four case studies that are used to exemplify the contents of the lecture by applying the concepts to real situations in corporate life.

Strategic Supply Chain Management

W+ 3 credits 2G S. Wagner

Abstract
The course offers an introduction to the theory and practice of supply chain management. Students will learn how to develop supply chain strategies and supply chain networks based on firms competitive strategies and marketing priorities.

Objective
The task of designing and managing supply chains requires that managers apply strategic, decision making and leadership skills in a supply chain context. The goal of this course is to develop and practice these skills.

Effective supply chains ought to be aligned with and support the achievement of the firms corporate, business and product strategies, taking into account future opportunities and risks. This course will familiarize students with modern supply chain management theory and practice to develop and manage supply chains. The topics covered range from fundamental logistics and supply chain concepts (e.g. push vs. pull, postponement) to the development of supply chain strategies, relationships and networks.

Course material will be available for download from the homepage of the Chair of Logistics Management:

http://www.scm.ethz.ch/teaching/courses.html

Login will be provided in the first lecture or can be obtained from the Teaching Assistant Dagmar Reinerth (dreinerth@ethz.ch).

The following textbook is mandatory:


The following textbook is supplementary:


Prerequisites / notice

The final course grade will be a weighted average of the following:

Exam (semester end): 70%
Case studies (during the semester): 30%

Students (at least in groups of two) must bring a laptop with MS Excel and the Excel Solver installed at class.

Quantitative and Qualitative Methods
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0305-00L</td>
<td>Empirical Methods in Management</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>A. Scherer</td>
</tr>
</tbody>
</table>

**Abstract**
Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.

**Objective**
- Ability to formulate research questions and designing an appropriate study
- Ability to collect and analyze data using a variety of methods
- Ability to critically assess the quality of empirical research in management
- Applied knowledge of empirical methods through out-of-class assignments

**Content**
1) Introduction to empirical management research
2) Research designs: exploratory, descriptive, experimental
3) Measurement and scaling
4) Data collection and sampling
5) Data analysis methods
6) Reporting and presenting empirical research

**Prerequisites / notice**
Assignments and projects: This course includes out-of-class assignments and projects to give students some hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. Students will have at least one week to work on each assignment. Students are expected to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned-in on time.

**Class participation:** Class participation is encouraged and can greatly improve students’ learning in this class. In this spirit, students are expected to attend class regularly and come to class prepared.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-1004-00L</td>
<td>Operations Research</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>M. Laumanns</td>
</tr>
</tbody>
</table>

**Abstract**
This course provides an introduction to operations research methods in the fields of management science and economics. Requisite mathematical concepts are introduced with a practical, problem-solving perspective.

**Objective**
- Introduction to building and using quantitative models in a business / industrial environment
- Introduction to basic optimization techniques (Linear Programming and extensions, network flows, integer programming, dynamic and stochastic optimization)
- Understanding the integration of quantitative models into the managerial decision process

**Content**
The following topics are covered: Systems and models, linear models and the importance of linear programming, duality theory and shadow prices, integer programming, optimization under uncertainty and applications in inventory management.

**Lecture notes**
A printed script will be made available.

**Literature**
Any standard textbook in Operations Research is a useful complement to the course.

**Prerequisites / notice**
Undergraduate calculus, linear algebra, probability and statistics are a prerequisite.

#### Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0537-00L</td>
<td>Resource and Environmental Economics</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>L. Bretschger, A. Brausmann</td>
</tr>
</tbody>
</table>

**Abstract**
Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

**Objective**
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

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Content
Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes
Learning material and script can be found here:
https://moodle-app2.let.ethz.ch/course/view.php?id=328

Literature

Financial Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0561-00L</td>
<td>Financial Market Risks</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>D. Sornette</td>
</tr>
</tbody>
</table>

Abstract
I aim to introduce students to the concepts and tools of modern finance and to make them understand the limits of these tools, and the many problems met by the theory in practice. I will put this course in the context of the on-going financial crises in the US, Europe, Japan and China, which provide fantastic opportunities to make the students question the status quo and develop novel solutions.

Objective
The course explains the key concepts and mechanisms of financial economics, their depth and then stresses how and why the theories and models fail and how this is impacting investment strategies and even a global view of citizenship, given the present developing crises in the US since 2007 and in Europe since 2010.

Content
1. The Financial Crises: what is really happening? Historical perspective and what can be expected in the next decade(s). Bubbles and crashes. The illusion of he perpetual money machine.
2. Risks in financial markets
   - What is risk?
   - Measuring risks of financial assets
   - Introduction to three different concepts of probability
   - History of financial markets, diversification, market risks
3. Introduction to financial risks and its management.
   - Relationship between risk and return
   - Portfolio theory: the concept of diversification and optimal allocation
   - How to price assets: the Capital Asset Pricing Model
   - How to price assets: the Arbitrage Pricing Theory, the factor models and beyond
4. Financial markets: role and efficiency
   - What is an efficient market?
   - Financial markets as valuation engines: exogeneity versus endogeneity (reflexivity)
   - Deviations from efficiency, puzzles and anomalies in the financial markets
   - Financial bubbles, crashes, systemic instabilities
5. An introduction to Options and derivatives
   - Calls, Puts and Shares and other derivatives
   - Financial alchemy with options (options are building blocs of any possible cash flow)
   - Determination of option value; concept of risk hedging
6. Valuation and using options
   - A first simple option valuation model
   - The Binomial method for valuing options
   - The Black-scholes model and formula
   - Practical examples and implementation
   - Realized prices deviate from these theories: volatility smile and real option trading
   - How to imperfectly hedge with real markets?
7. Real options
   - The value of follow-on investment opportunities
   - The timing option
   - The abandonment option
   - Flexible production
   - Conceptual aspects and extensions
8. Government bonds and their valuation
   - Relationship between bonds and interest rates
   - Real and nominal rates of interest
   - Term structure and Yields to maturity
   - Explaining the term structure
   - Different models of the term structure
9. Managing international risks
   - The foreign exchange market
   - Relations between exchanges rates and interest rates, inflation, and other economic variables
   - Hedging currency risks
   - Currency speculation
   - Exchange risk and international investment decisions

Lecture notes
Lecture slides will be available on the site of the lecture
363-0723-00L Corporate Finance

Abstract
Corporate Finance, investment management, business valuation, value based management & compensation, financial reporting today & in future, financial reporting value chain, reporting on non-financial measures, such as corporate sustainability reporting, mergers & acquisitions, legal aspects, taxes, corporate governance - risk management - internal controls & mgmt. information systems, turnaround.

Objective
Introduction in theory and practical application of Corporate Finance, with a particular focus on financing of operations and transactions, analysed from multiple aspects, including legal and tax.

Content
Lectures Slides in English will be available for download on the following website: https://ilias-app2.let.ethz.ch/ilias.php?target=crs_66558&client_id=ilias_lda

Literature

363-0311-00L Psychological Aspects of Risk Management and Technology

Abstract
Using uncertainty management by organizations and individuals as conceptual framework, risk management and risk implications of new technologies are treated. Three components of risk management (risk identification/evaluation, risk mitigation, risk communication) and underlying psychological and organizational processes are discussed, using company case studies to promote in-depth understanding.

Objective
- understand basic components of risk management in organizations
- know and apply methods for risk identification/evaluation, risk mitigation, risk communication

Content
- know psychological foundations of risk perception, decision-making under risk, and risk communication
- know organizational principles for managing uncertainty
- apply theoretical foundations to applied issues such as safety management, regulatory activities, and technology design and implementation in different domains (e.g. transport systems, IT, insurance)

Lecture notes
There is no script, but slides will be made available before the lectures.

Literature
There are texts for each of the course topics made available before the lectures.

Prerequisites / notice
The course is restricted to 40 participants who will work closely with the lecturers on case studies prepared by the lecturers on topics relevant in their own companies (Swiss Re, Skyguide, Swisscom).

365-0351-00L Presentation Skills

Abstract
Pre-registration required: Monday 12.09.2016 (10:00) to Thursday 22.09.2016 (10:00) via Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=2360. Once your pre-registration has been confirmed, a registration in myStudies is possible as of 26 September 2016.

Objective
This course will cover how to prepare and deliver your future presentations. You will be more confident presenting yourself. Thanks to the feedback from your colleagues, the trainer and the video you will be able to identify your strengths and weaknesses.

Content
This course will cover how to prepare and deliver your future presentations. The following contents will be covered: the most important elements of a professional presentation, their presentations are more professional and interesting than before, they can structure their presentation for easy delivery and understanding, they can tell what their strengths and areas for improvement are, they will know how to speak of the cuff, they deliver constructive feedback.

Literature
Skipwith, Thomas; Reto B. Rüegger: To catch fish use the right bait, DESCUBRIS Press, Zurich, May 2014.
This course focuses on the challenges in managing multi-business corporations, and covers topics related to the vertical and horizontal scope of business activities.

70% of the final grade consists of a final closed-book written exam and 30% of the final grade will consist of individual/group assignments.

The course Corporate Strategy draws from a wide range of theories and methods to develop an understanding of the conceptual frameworks, debates, and developments concerning decisions associated with the management of multi-business corporations. We will cover the key questions driving a firm's corporate strategy, including:

- In what markets to compete with which businesses?
- Which activities should be performed by the firm and which should be outsourced (i.e. "make" or "buy" decisions)?
- What are the most appropriate approaches to growth and divestiture?
- How do institutional forces impact corporate strategy?

Specifically, we will examine how organizations manage their portfolio of business activities and markets to achieve competitive advantage through vertical integration, cooperative strategies such as strategic alliances and joint ventures, corporate diversification, mergers and acquisitions, divestitures, and globalization/international strategies, and strategic renewal.

Format:

The course is a combination of lectures about concepts/methods, guest lectures, case studies/assignments, and group debates/assignments.

The course homepage can be found at: http://www.smi.ethz.ch/education/courses/corporatestrategy

Having participated in the course Strategic Management by Prof. Georg von Krogh/Dr. Zeynep Erden is an advantage but not a requirement.

<table>
<thead>
<tr>
<th>363-0861-00L</th>
<th>Alliance Advantage - Exploring the Value Creation</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>C. G. C. Marxt</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td><strong>Potential of Collaborations</strong></td>
<td></td>
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</tr>
<tr>
<td>Learning outcomes professional competence</td>
<td>The development of new business models coping with the constantly augmenting complexity of technologies and systems as well as the ever increasing global competition force organizations to focus on close collaboration with key partners. These alliances are key value creation opportunities and constitute the core part of this lecture.</td>
<td></td>
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</tbody>
</table>
| Learning outcomes methodological competence | - The students learn and understand the management basics of inter-firm cooperation and organizational networks (business models, incl. risk, communication, etc.)
- realize the value creation potentials of alliances (added value)
- understand underlying theoretical models (Transaction cost theory, principal agent, game theory)
- Identify and understand specific forms of collaboration (Strat. All., JV, Networks, M&A, etc.)
- Apply tools hands on in real companies (in coll. with companies) |
| Learning outcomes social competence | - Writing academic papers
- Developing structured documentation of interviews
- Transferring theory directly into application
- Contributing to the learning journey |
| Content | The constantly augmenting complexity of technologies and systems, the increased pressure caused by competition, the need for shortening time-to-market and the thereby implied growing risks force organizations to increasingly focus on core competencies. Collaboration with external partners is a key value creation opportunity for successful ventures. This type of cooperation also has implications on daily management activities. This lecture will provide a better understanding of special requirements needed for management of cooperation issues. Content: 
- Introduction to theory and management of inter-firm collaboration and networks.
- Description of the formation, management and evolution of collaborations and networks.
- Collaborations in marketing, development, manufacturing (e.g. NUMMI).
- Special forms of collaborations: mergers & acquisition (e.g. pre- and post-merger activities, joint venture, strategic alliances (e.g. Doz & Hamel, networks, virtual communities) |
| Learning journey: | In an introductory lecture we will give an overview of the theoretical framework and explain the concept of the lecture (Sept. 18, 2014). In weeks 2-5 you will work on a first assignment on six different aspects of the underlying framework: strategy and activities, structure and process, culture and people orientation, interaction and roles, risk and trust, knowledge and learning. This first assignment will give you the basics to participate in the second part (Oct.30-31.2014, 2014) of this seminar. There you will present the results of the first assignment and get additional theoretical input to perform the 2nd assignment. The second assignment will be to analyze real alliance projects in the partner companies. The final lesson will be used as a best practice exchange together with our industrial partners (Dec.18, 2014). |
| Lecture notes | - Lecture script
- Current course material
- Harvard Case Studies
- Reader with current papers |
| Literature | A list with recommended publications will be distributed in the lecture. |

Additional Books:
- HBR Collaborating Effectively ISBN 978-1-4221-6264 4
- HBR on Mergers and Acquisitions: ISBN 1-57851-555-6
Prerequisites / notice
The number of students participating in the lecture is limited to 30.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>W</th>
<th>Credits</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>351-0555-00L</td>
<td>Open- and User Innovation</td>
<td>3</td>
<td>2G</td>
<td>S. Häfliger, S. Spaeth</td>
</tr>
</tbody>
</table>

Abstract
The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.

Objective
The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management and develop strategies to harness the value of user-developed ideas and contributions for firms and other organizations. The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.

The course presents and builds upon recent research and challenges the students to devise innovation strategies that take into account the availability of user expertise, free and public knowledge, and the interaction with communities that span beyond one organization.

Grading is based on the final exam, the class presentations (including the slides) as well as class participation.

Content
This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structuration of technology, and an introduction to entrepreneurship.

Lecture notes
The slides of the lectures are made available and updated continuously through the SMI website:

Literature
Relevant literature for the exam includes the slides and the reading assignments. The corresponding papers are either available from the author online or distributed during class.

Reading assignments: please consult the SMI website:
The course is intended for students who want to carry out a thesis in industry, in general these are:

1. MSc-students MTEC or MAVT with master thesis (MA) during the next term and supervised by MTEC, (corresponds to 3rd or 4th semester Master) and
2. BSc-students MAVT with bachelor thesis (BA) in industry and supervised by MTEC, as well as with full MTEC focus (corresponds to 5th or 6th semester Bachelor) or
3. MAS MTEC students in 3rd semester for MA during the next term.

Important note: Credits will only be awarded to students according to (1), (2) or (3). Prerequisites for obtaining the credit or "Testat": being present during the whole course (presence list) and prior study of documents provided on the Internet and of the book Züst, R.: Einstieg ins Systems Engineering, 3. Aufl., Verlag Industrielle Organisation, Zürich 2004.

Other students on request (limited places).

Important: the chair coaching your BA/MA defines whether the course is mandatory. Please contact your chair!

Electronic enrollment until 08.09.2015 required. Without electronic enrollment participation in the course can't be confirmed. The course is held "en bloc" at the beginning of the semester.

Date: Friday 11.09.2015 (13:15-17:00), location: HG E33.1 (ETH main building) and Saturday, 12.09.2015 (09:15-17:00), location: HG E33.1 (ETH main building). Participation at both days required (Friday afternoon and Saturday whole day).

The course is held in English; handouts are available in English.

Besonderes (deutsche Version):

Der Kurs richtet sich an Studierende, welche an einer Professur des D-MTEC eine Arbeit in der Wirtschaft schreiben werden. Im Allgemeinen sind dies:

1. MSc-Studierende MTEC oder MAVT mit Masterarbeit (MA) im kommenden Semester, die vom MTEC betreut wird, (entspricht 3. oder 4. Semester Master) sowie
2. BSc-Studierende MAVT mit Bachelorarbeit (BA) in der Wirtschaft, die vom MTEC betreut wird, sowie mit vollem MTEC Fokus (entspricht 5. oder 6. Semester Bachelor) oder


Andere Studierende auf Anfrage (beschränkte Anzahl Plätze).

Wichtig: die Professor, welche die jeweilige BA/MA betreut, legt fest, ob der Besuch der Veranstaltung obligatorisch ist. Bitte informieren Sie sich dort!

Elektronische Einschreibung bis zum 08.09.2015 notwendig. Ohne elektronische Einschreibung kann Ihre Teilnahme am Kurs nicht bestätigt werden.

Der Kurs wird als Blockkurs zu Beginn des Semesters gehalten.

Termin: Freitag, den 11.09.2015 (13:15-17:00) im HG E33.1 und Samstag, 12.09.2015 (09:15- ca. 17:00) im HG E33.1 (ETH Hauptgebäude). Anwesenheitspflicht an beiden Tagen (Freitagnachmittag und Samstag ganztags).

Die Veranstaltung wird auf Englisch gehalten; Handouts sind in Englisch verfügbar.

Important note: Credits will only be awarded to students according to (1), (2) or (3). Prerequisites for obtaining the credit or "Testat": being present during the whole course (presence list) and prior study of documents provided on the Internet and of the book Züst, R.: Einstieg ins Systems Engineering, 3. Aufl., Verlag Industrielle Organisation, Zürich 2004.

Andere Studierende auf Anfrage (beschränkte Anzahl Plätze).

Wichtig: die Professor, welche die jeweilige BA/MA betreut, legt fest, ob der Besuch der Veranstaltung obligatorisch ist. Bitte informieren Sie sich dort!

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Die Veranstaltung wird auf Englisch gehalten; Handouts sind in Englisch verfügbar.

Prerequisites / notice

(1) MSc-students MTEC or MAVT with master thesis (MA) during the next term and supervised by MTEC, (corresponds to 3rd or 4th semester Master) and
(2) BSc-students MAVT with bachelor thesis (BA) in industry and supervised by MTEC, as well as with full MTEC focus (corresponds to 5th or 6th semester Bachelor) or
(3) MAS MTEC students in 3rd semester for MA during the next term.

Important note: Credits will only be awarded to students according to (1), (2) or (3). Prerequisites for obtaining the credit or "Testat": being present during the whole course (presence list) and prior study of documents provided on the Internet and of the book Züst, R.: Einstieg ins Systems Engineering, 3. Aufl., Verlag Industrielle Organisation, Zürich 2004.

Other students on request (limited places).

Important: the chair coaching your BA/MA defines whether the course is mandatory. Please contact your chair!

Electronic enrollment until 08.09.2015 required. Without electronic enrollment participation in the course can't be confirmed. The course is held "en bloc" at the beginning of the semester.

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The course is held in English; handouts are available in English.

Besonderes (deutsche Version):

Der Kurs richtet sich an Studierende, welche an einer Professur des D-MTEC eine Arbeit in der Wirtschaft schreiben werden. Im Allgemeinen sind dies:

1. MSc-Studierende MTEC oder MAVT mit Masterarbeit (MA) im kommenden Semester, die vom MTEC betreut wird, (entspricht 3. oder 4. Semester Master) sowie
2. BSc-Studierende MAVT mit Bachelorarbeit (BA) in der Wirtschaft, die vom MTEC betreut wird, sowie mit vollem MTEC Fokus (entspricht 5. oder 6. Semester Bachelor) oder


Andere Studierende auf Anfrage (beschränkte Anzahl Plätze).

Wichtig: die Professor, welche die jeweilige BA/MA betreut, legt fest, ob der Besuch der Veranstaltung obligatorisch ist. Bitte informieren Sie sich dort!

Elektronische Einschreibung bis zum 08.09.2015 notwendig. Ohne elektronische Einschreibung kann Ihre Teilnahme am Kurs nicht bestätigt werden.

Der Kurs wird als Blockkurs zu Beginn des Semesters gehalten.

Termin: Freitag, den 11.09.2015 (13:15-17:00) im HG E33.1 und Samstag, 12.09.2015 (09:15- ca. 17:00) im HG E33.1 (ETH Hauptgebäude). Anwesenheitspflicht an beiden Tagen (Freitagnachmittag und Samstag ganztags).

Die Veranstaltung wird auf Englisch gehalten; Handouts sind in Englisch verfügbar.

Important note: Credits will only be awarded to students according to (1), (2) or (3). Prerequisites for obtaining the credit or "Testat": being present during the whole course (presence list) and prior study of documents provided on the Internet and of the book Züst, R.: Einstieg ins Systems Engineering, 3. Aufl., Verlag Industrielle Organisation, Zürich 2004.

Andere Studierende auf Anfrage (beschränkte Anzahl Plätze).

Wichtig: die Professor, welche die jeweilige BA/MA betreut, legt fest, ob der Besuch der Veranstaltung obligatorisch ist. Bitte informieren Sie sich dort!

Elektronische Einschreibung bis zum 08.09.2015 notwendig. Ohne elektronische Einschreibung kann Ihre Teilnahme am Kurs nicht bestätigt werden.

Der Kurs wird als Blockkurs zu Beginn des Semesters gehalten.

Termin: Freitag, den 11.09.2015 (13:15-17:00) im HG E33.1 und Samstag, 12.09.2015 (09:15- ca. 17:00) im HG E33.1 (ETH Hauptgebäude). Anwesenheitspflicht an beiden Tagen (Freitagnachmittag und Samstag ganztags).

Die Veranstaltung wird auf Englisch gehalten; Handouts sind in Englisch verfügbar.
Objective
This course teaches students about the basic principles of scientific work in the field of social sciences. The goal is to motivate students to develop an own thesis design and write scientific articles.

Content
This course teaches students about the basic principles of scientific work in the field of social sciences. It is an introduction into the fascinating field of research. The course shows the power of theory and literature, helps formulating intriguing research questions, provides an overview of scientific methods and data analysis, and gives hints on how to derive insightful conclusions out of results. The goal is to motivate students to find and read research papers relevant to their field, develop an own thesis design and write scientific articles.

Literature
Nicolay Siggelkow (2007) Persuasion with Case Studie AMJ Vol. 50, No. 1

Prerequisites / notice
The course is mandatory for MSc. students and recommended for MAS students who write their Master Thesis at the Chair of Strategic Management and Innovation - those will be served first.
- The course will be given once every semester by Dr. Zeynep Erden Özkol and the PhD students of the chair
- The course takes two days, one for lecture, one for student paper presentations. Participation to both sessions are mandatory to receive the credit, there will be no exceptions.
- Students who participate in the lecture and present a paper receive 1 credit point. The course and the presentations will be given in English.
- Students might benefit more if they take this course towards the end of their studies, before writing their master thesis.

363-0445-02L Production and Operations Management (Additional Cards)
Objective
Extension to course 363-0445-00 Production and Operations Management.

Content
Additional cases to course 363-0445-00 Production and Operations Management.

363-0622-00L Basic Management Skills
Objective
To convey management behaviour based on practical examples, own experiences and team discussions complemented by short theory sessions (subsidized from the donation for promotion and training in enterprise sciences at the ETHZ).

Content
1 Fundamentals of Communication Psychology
2 Communication in Business-Life
3 Fundamentals of Leadership
4 Self-Management and Life Balance
5 Leadership Tools
6 Problem Solving and Decision Making Techniques
7 Performance Coaching
8 Conflict Management
9 Personality
10 Summary-Day, Domino-Examination

Lecture notes
Will be provided as electronic version at www.entrepreneurship.ethz.ch at least one week before the seminar starts

Prerequisites / notice
Limited number of participants: Mandatory registration required.

365-1019-00L Human Resource Management: Skills in Practice
Objective
Exclusive for MAS MTEC students (third semester).

Content
Limited number of participants: a minimum of 10 persons and a maximum of 25 persons. Please register by 27.10.2016 at the latest via myStudies

Prerequisites: Prior participation in the lecture "Human Resource Management: Leading Teams" (363-0302-00L)
### Entrepreneurial Leadership

**Abstract**

Based on several core Human Resource Management processes, this seminar teaches practical skills in HRM and leadership in teams.

**Objective**

Participants are able to cope with potentially difficult HRM-related situations they may encounter as line managers and team leaders.

**Content**

Based on several core Human Resource Management processes (e.g., recruiting, performance management, reward, training and development), this seminar teaches practical skills in HRM and leadership in teams from a managerial point of view. Using a variety of interactive methods (e.g., role plays) and discussions of real-life situations, it provides a highly practice-oriented approach to dealing with potential HRM- and team-related conflicts at work.

**Literature**

Prior participation in Prof. Grote’s lecture ‘Human Resource Management: Leading Teams’ is highly recommended.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>W</th>
<th>Credits</th>
<th>ECTS</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-1028-00L</td>
<td>Entrepreneurial Leadership</td>
<td></td>
<td>4</td>
<td>3S</td>
<td>C. P. Siegenthaler, P. Baschera, G. von Krogh</td>
</tr>
<tr>
<td></td>
<td>(Limited number of participants.)</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Prerequisites / notice**

Students apply with motivation letter, CV and a transcript of records no later than 22.8.2016. Earlier applications welcome. Send application to mtec-els@ethz.ch. Once your application is confirmed, a registration in myStudies is possible.

**Abstract**

This seminar provides master students at MTEC with the challenging opportunity of a real case on strategy, innovation and leadership in close collaboration with the top management of leading Swiss technology company.

**Objective**

In your team, you will work on a specific assignment that flows from the current strategic agenda of the board. While gaining substantial insights into the structure, dynamics and challenges of the industry, you immerse into the business model and strategic landscape of the corporate partner. You visit their headquarter, conduct interviews with members of the management team as well as internal and external experts before you discuss your ideas with top executives. To secure impact, it is key that you formulate your recommendations from a deep understanding of the authentic leadership culture of the corporate partner.

**Content**

In this endeavour you are coached and supported by:
- Gudela Grote, Chair of Work and Organizational Psychology
- Stefano Brusoni, Chair of Technology and Innovation Management
- Claude Siegenthaler, Business School Lausanne / The St.Gallen MBA
- Gudela Grote, Chair of Strategic Management and Innovation
- Pius Baschera, former Chair of Entrepreneurship

**Prerequisites / notice**

Please apply for this course via the official website (www.mtec.ethz.ch) - to be opened by end of May 2016. Apply no later than August 22.

The number of participants is limited to 18.

ECTS: 4

Participants receive a certificate.

### Monetary Policy

**Abstract**

The main aim of this course is to analyse the goals of monetary policy and to review the instruments available to central banks in order to pursue these goals. It will focus on the transmission mechanisms of monetary policy and the differences between monetary policy rules and discretionary policy. It will also make connections between theoretical economic concepts and current real world issues.

**Objective**

This lecture will introduce the fundamentals of monetary economics and explain the working and impact of monetary policy.

**Literature**

This course will be based on chapters of:

**Prerequisites / notice**

Basic knowledge in international economics and a good background in macroeconomics. The course website can be found at: https://moodle-app2.let.ethz.ch/course/view.php?id=2457

### Harvard Business School: Financial Accounting Online

**Abstract**

Exclusively for MAS MTEC students (first semester).

The online course will be open from 19.09.2016 to 22.01.2017. Within this time, students can proceed through the course at their own convenience. Seat time is about 25 hours.

All MAS MTEC students will receive further information by e-mail on 19.09.2016.

**Objective**

This course is a web-based, online, interactive introduction to financial accounting within the context of management requirements. It has been developed by Harvard Business Publishing.

**Content**

1. Introductory Section
   1.1 Terms and Concepts
   1.2 The Balance Sheet
   1.3 Income Statement
   1.4 Accounting Records
   1.5 The Statement of Cash Flows
   2. Advanced Section
   2.1 Revenue & Receivables
   2.2 Inventories and Cost of Sales
   2.3 Depreciation and non-current Assets
   2.4 Liabilities and Financing Costs
   2.5 Investment & Investment Income
   2.6 Deferred Taxes and Tax Expense
   2.7 Owner’s Equity

**Lecture notes**

The Financial Accounting online-course is an ideal complement to the lectures “Accounting for Managers (363-0711-00)” as well as “Financial Management (363-0560-00)” with the purpose to further deepen the student’s knowledge of accounting. Parts of the course content are overlapping, however, it is provided in a different context. Not covered in the online course is managerial accounting which is an important topic in the lecture “Accounting for Managers”.

**Literature**

 Needles & Powers (2010), Financial Accounting, 11e, South-Western College Pub
Prerequisites / notice
The online course will be open from 19.09.2016 to 22.01.2017. Within this time, students can proceed through the course at their own convenience. Seat time is about 25 hours. The online course should be accessed and activated only if students wish to take and complete it.

No lectures are offered for this course. Specific course topics can be discussed with other course participants, and any questions regarding the course content will be answered by an expert on the learning platform Moodle.

365-1035-00L Quality Management
W 3 credits 2S to be announced
M. Ambühl

Abstract
The design of this course is intended to introduce quality management from an operations and manufacturing viewpoint. Many of the key topics covered throughout the course can be located in the Content section below.

Objective
This course will provide students with the underlying principles and techniques surrounding Quality Management with an emphasis on the application in manufacturing and services settings. Students will develop a working knowledge of the best practices in Quality and Process Management. Students will learn to view quality from a variety of functional perspectives and in the process, gain a better understanding of the problems associated with improving quality. The course aims to impart knowledge on the quality management process and key quality management activities. Specifically it aims to: Compare and contrast the various tools used in quality management, comprehend the concepts of customer's value, discuss the emerging tendencies toward global competitiveness, understand different perspectives on quality, explore six-sigma management and its tools, demonstrate how to design quality into product and services, describe the importance of developing a strategic plan for Quality Management, and discuss the importance of 'benchmarking' as a means of identifying the choice of markets.

Content
Major Topics:
Total Quality Management (TQM): Excellence in manufacturing/service, factors of excellence, applications of TQM
Process Management: Quality function development (QFD) and quality assurance systems, factors affecting process management
Benchmarking Procedures
Statistical Process Control (SPC) and failure mode and effect analysis (FMEA) procedures
Demming's 14 points of Management
Continuous Improvement
Supplier Evaluation: Managing Supplier Quality
Manufacturing capabilities: Quality as a core focus, cost management, competencies
Environmental Factors: Turbulent environments, manufacturing intensity, uncertainty
Quality Systems Certification Policy:
Six Sigma
ISO 9001, 9002, 9003 / ISO 14001 (Environmental quality policies)

Literature
Readings:
Required:
Recommended:

363-1049-00L Contemporary Conflict Management
W 3 credits 2V M. Ambühl, S. C. Zürcher

Abstract
The course provides students with theoretical background and practical insights in conflict management in the 3 areas international, business and interpersonal (legal) relations. Students are introduced into theoretical concepts related to the research field and real world case studies including examples of international conflicts, WWI, old and new regional conflicts, business and mediation.

Objective
Students will gain:
- knowledge of history of conflict management;
- comprehension of major ideas in the theory and practice of conflict management, mediation, transformation and resolution;
- application of theoretical concepts to current conflict situations;
- evaluation of conflict situations in international relations and business.

Content
The following topics will be covered:
- history of international and regional conflicts;
- theoretical concepts of conflict management;
- theoretical models of arms races and conflict escalation;
- case studies in international conflicts, as well as in business.

Distinguished guest speakers will be invited.
Managing the Technology Driven Enterprise

W 2 credits 1S  P. Bubenzer

Exclusively for MAS MTEC students (third semester).

Limited number of participants: a minimum of 20 and a maximum of 40 persons.

Please register through myStudies to enrol for the course no later than 10.10.2016.

Abstract

This interactive course provides leaders in technology-driven enterprises with critical insights and tools for addressing key challenges in innovation management.
This course offers an intensive, two-day integrated learning experience to provide leaders in technology-driven enterprises with critical insights and tools for tackling key innovation management challenges. The course combines an innovative set of lectures with practical case studies and group exercises taught by seasoned industry executives with experience in technology-driven start-ups and large firms in a variety of industries. Unlike more traditional courses, this is a highly interactive immersion into real-life challenges where established frameworks and contemporary models are used to develop leadership capabilities in technologically complex business environments. This course is thus designed to particularly suit the needs and expectations of engineers or other technology specialists who intend to develop into more general leadership roles in technology based enterprises.

This course is tailored to, firstly, enable participants to understand key concepts of technology and innovation management and, secondly, gain practical “real-life based” leadership skills that improve their ability to implement massive innovative change in today’s dynamic global work and marketplace. In consequence, the first part of the course explores foundational frameworks in technology and innovation management with a particular focus on the evolution and adoption of technology-based innovations. The second part of the course, then, provides tools for successfully implementing innovation initiatives at all levels - individual, project and organization.

Literature

Literature and readings will be announced beforehand.

### Master’s Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>365-0899-00L</td>
<td>Master’s Thesis in a Company</td>
<td>O</td>
<td>12 credits</td>
<td>24D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

**Abstract**

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and is performed within a private company.

**Objective**

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and is performed within a private company.

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**MAS in Management, Technology, and Economics - Key for Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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</table>
### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Introduction to structure and function of the human body. The lectures will be based on current clinical practices in Radiology, Neuroradiology and Nuclear Medicine. Non-physiological and anatomical knowledge of the human body to ensure the correct understanding of basic concepts and to facilitate the collaboration of medical physicists and other health professionals.

Title: Anatomy and Physiology for Medical Physicists I
Type: O
ECTS: 2
Hours: 2V
Lecturers: F. Kuhn

Abstract: Introduction to structure and function of the human body. The lectures will be based on current clinical practices in Radiology, Neuroradiology and Nuclear Medicine. After an introduction to cells and tissues the following systems will be addressed: 1) Support & Movement (musculoskeletal system, biomechanics); 2) Neuroscience (central and peripheral nervous system); 3) Auto-regulation (endocrine system) & Internal Transport (blood & cardiovascular system); 4) Environmental Exchange (respiratory, urinary, digestive & reproductive system).

Title: Biostatistics
Type: O
ECTS: 4
Hours: 2+1U
Lecturers: B. Sick

Abstract: The course deals with simple quantitative and graphical as well as more complex methods of biostatistics. Contents: Descriptive statistics, probability theory and design of experiments, testing hypotheses, confidence intervals, correlation, simple and multiple linear regression, classification and prediction, diagnostic tests, measurement of agreement.

Title: Biomedical Imaging
Type: O
ECTS: 6
Hours: 5G
Lecturers: S. Kozerke, K. P. Prüssmann, M. Rudin

Abstract: Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective: To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content:
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes: Lecture notes and handouts.


Prerequisites / notice: Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming.

Title: Physics in Radiodiagnostics and Nuclear Medicine
Type: O
ECTS: 2
Hours: 3G
Lecturers: F. Bochud

Abstract: The course is dedicated to introduce MAS students from Medical Physics to the field of radiodiagnostic and nuclear medicine. Dedicated practicals will illustrate the theory with an emphasis on the relationship between dose and image quality as well as the security problems related to the work with radiations.

Objective: This 1-week theory and practical class offers the possibility to enjoy a variety of research and clinical areas in diagnostic and nuclear medicine. It gives insight into practical concepts and techniques that are discussed thoroughly as the class is performed within actual laboratories with real radiation sources.

Content: The course starts with the physical basis of radiography (from X-ray production to image detectors) and continues with the basic parameters of image quality in radiography (contrast, resolution, noise) and their measurement methods. Specific applications of radiation diagnostic are then considered separately. The physics of fluoroscopy and mammography is presented with emphasis on the type of detectors. Computer tomography starts from mono- to multi-detector row technology and finishes with the dose indicators and the impacts of acquisition parameters on patient dose. Nuclear medicine is approached through the production and labeling of radiopharmaceuticals before explaining the aspects related to quality control like the stability of the compounds, nuclide- and radionuclide purity as well as apropogenecity and sterility. Imaging aspects of nuclear medicine are treated in details for SPECT and PET through the instrumentation, the reconstruction algorithms and the corresponding image quality.

Finally, the aspects related to patient dose and radiation protection of the personnel are considered separately for diagnostic radiology and nuclear medicine. The general frameworks of external as well as internal irradiation are presented and practical examples of dose calculations are explained.

Specialization: Radiation Therapy

Core Courses

Number: 402-0341-00L
Title: Medical Physics I
Type: O
ECTS: 6
Hours: 2+1U
Lecturers: P. Manser

Abstract: Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

Objective: Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.

Content: The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the excercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications. A script will be provided.

Number: 227-0943-00L
Title: Radiobiology
Type: O
ECTS: 2
Hours: 2V
Lecturers: M. Pruschy

Abstract: The course deals with simple quantitative and graphical as well as more complex methods of biostatistics. Contents: Descriptive statistics, probability theory and design of experiments, testing hypotheses, confidence intervals, correlation, simple and multiple linear regression, classification and prediction, diagnostic tests, measurement of agreement.
Abstract
The purpose of this course is to impart basic knowledge in radiobiology in order to handle ionizing radiation and to provide a basis for predicting the radiation risk.

Objective
By the end of this course the participants will be able to:

a) interpret the 5 Rs of radiation oncology in the context of the hallmarks of cancer
b) understand factors which underpin the differing radiosensitivities of different tumors
c) follow rational strategies for combined treatment modalities of ionizing radiation with targeted agents
d) understand differences in the radiation response of normal tissue versus tumor tissue
e) understand different treatment responses of the tumor and the normal tissue to differential clinical-related parameters of radiotherapy (dose rate, LET etc.).

Content
Einführung in die Strahlenbiologie ionisierender Strahlen: Allgemeine Grundlagen und Begriffsbestimmungen; Mechanismen der biologischen Strahlenwirkung; Strahlenwirkung auf Zellen, Gewebe und Organe; Modifikation der biologischen Strahlenwirkung; Strahlentherapie: Chromosomenveränderungen, DNA-Defekte, Reparaturprozesse; Molekulare Strahlenbiologie: Bedeutung inter- und intrazellulärer Signalübermittlungsprozesse, Apoptose, Zellzyklus-Checkpoints; Strahlensńsk: Strahlensyndrom, Krebsinduktion, Mutation, Mutagenese, präneoplastische Strahlenwirkung; Strahlenbiologische Grundlagen des Strahlenschutzes; Nutzen-Risiko-Abwägungen bei der medizinischen Strahlentherapie: Prädiktive strahlenbiologische Methoden zur Optimierung der therapeutischen Strahlenanwendung.

Lecture notes
Beilagen mit zusammenfassenden Texten, Tabellen, Bild- und Grafikdarstellungen werden abgegeben

Literature
Literaturliste wird abgegeben.

Prerequisites / notice

The former number of this course unit is 465-0951-00L.

Practical Work

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>465-0956-00L</td>
<td>Dosimetry Only for MAS in Medical Physics</td>
<td>O</td>
<td>4 credits</td>
<td>6G</td>
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</tr>
</tbody>
</table>

Abstract
Dosimetry in radiotherapy. Planning and implementation of a percutaneous radiation exposure on an anthropomorphic phantom.

Objective
Praktische Umsetzung der Lerninhalte der Vorlesungen Medizinphysik I & II bezüglich Dosimetrie bei perkutanen Strahlenexpositionen

Content
Dosimetrie in der Strahlentherapie. Planung und Durchführung einer perkutanen Strahlenexposition an einem anthropomorphen Phantom. Überprüfung der resultierenden Dosisverteilungen.

Lecture notes
Die Kursunterlagen werden im Blockkurs abgegeben.

Prerequisites / notice
Voraussetzung: Besuch der Vorlesung Medizinische Physik I

Specialization: General Medical Physics and Biomedical Engineering

Major in Radiation Therapy

Core Courses

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0345-00L</td>
<td>Introduction to Medical Physics</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>A. J. Lomax</td>
</tr>
</tbody>
</table>

Abstract
Medical physics is a fascinating and worthwhile scientific discipline, providing many professional opportunities to apply physics to the care of patients, either in the clinic or in industry. It is also an area allowing for exciting, interesting and fulfilling areas of research.

Objective
It is the aim of this course to give bachelor and master level students an insight into the wide spectrum of medical applications of physics, and to provide some insight into the work of the medical physicist in clinics, industry and research.

Content
The lecture series will begin with a short historical overview of medical physics and an overview of the lecture series (lecture 1). This will be followed by two lectures on the physics of medical imaging. Medical imaging is one of the most important areas of preventive medicine and diagnostics, and in these two lectures, we will summarise the physics aspects of all the most important medical imaging modalities (X-ray, nuclear medicine, CT, MRI, Ultrasound imaging etc.). With lectures 4 and 5, we will move onto one of the other major areas of physics applied to medicine, radiotherapy. As the name implies, this is a physics ‘heavy’ discipline, being dependent as it is on both accelerator and particle physics. However, what is less well known is that this is also the second most successful treatment of cancer after surgery and a great success story for the application of physics to medicine. In lectures 6 and 7 we will then move on to a very different area, that of bio-photonics and bio-physics. Here we will look into the applications of lasers in medicine, from therapy to their use in particle acceleration for medical applications, as well as a variety of optical techniques for studying biological tissues, cells and structures.

In the second half of the lecture series (lectures 8-13) the style changes somewhat, and we will concentrate on professional aspects of medical physics and the role of the medical physicist in various professional scenarios. As such, lectures 8-11 will cover the role of the clinical medical physicist in diagnostic radiology, MRI, nuclear medicine and radiotherapy, whilst the last two lectures will concentrate on their role in industry and research. For many of this second set of lectures, external experts in the various areas will be invited in order to give the student the best possible insight into the life of a professional medical physicist.

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0341-00L</td>
<td>Medical Physics I</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>P. Manser</td>
</tr>
</tbody>
</table>

Abstract
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiologically and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

Objective
Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.

Content
The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the exercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

Lecture notes
A script will be provided.

227-0943-00L Radiobiology  W  2 credits  2V  M. Pruschny

Abstract
The purpose of this course is to impart basic knowledge in radiobiology in order to handle ionizing radiation and to provide a basis for predicting the radiation risk.

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 940 of 1571
Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a wide range of materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

The lecture includes an introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

The former number of this course unit is 465-0951-00L.
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconductor, oxide and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

### Major in Biomechanics

### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.</td>
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<tr>
<td>Lecture notes</td>
<td>Introduction to Biomedical Engineering by Enderle, Banchard, and Brombino</td>
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<tr>
<td>Literature</td>
<td>Available online</td>
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### 227-0965-00L

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<th>Number</th>
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</table>

| 376-1651-00L | Clinical and Movement Biomechanics | W   | 4    | 3G    | S. Lorenzetti, R. List, N. Singh |
| Abstract    | Measurement and modeling of the human movement during daily activities and in a clinical environment. |
| Objective   | The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application. |
| Content     | This course includes study design, measurement techniques, clinical testing, accessing movement data and analysis as well as modeling with regards to human movement. |
Trauma Biomechanics

**Abstract**
Trauma biomechanics in an interdisciplinary research field investigating the biomechanics of injuries and related subjects such as prevention. The lecture provides an introduction to the basic principles of trauma biomechanics.

**Objective**
Introduction to the basic principles of trauma biomechanics.

**Content**
This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact biomechanics, which uses the combination of fundamental engineering principles and advanced medical technologies to develop injury prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite element modelling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real world examples mainly from automobile safety are used to augment lecture material.

**Lecture notes**
Handouts will be made available.

**Literature**

### Practical Work

**Number** 465-0800-00L

**Title** Practical Work

**Type** O

**ECTS** 4 credits

**Hours** 2V+1U

**Lecturers**
external organisers

**Abstract**
The practical work is designed to train the students in the solution of a specific problem and provides insights in the field of the selected MAS specialization. Tutors propose the subject of the project, the project plan, and the roadmap together with the student, as well as monitor the overall execution.

**Objective**
The practical work is aimed at training the student's capability to apply and connect specific skills acquired during the MAS specialization program towards the solution of a focused problem.

### Electives

**Number** 151-0525-00L

**Title** Energy Conversion and Transport in Biosystems

**Type** W

**ECTS** 4 credits

**Hours** 2V+1U

**Lecturers**
D. Poulikakos, A. Ferrari

**Abstract**
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

**Objective**
Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

**Content**

**Lecture notes**
Material in the form of hand-outs will be distributed.

**Literature**
Lecture notes and references therein.

**Number** 151-0524-00L

**Title** Continuum Mechanics I

**Type** W

**ECTS** 4 credits

**Hours** 2V+1U

**Lecturers**
E. Mazza

**Abstract**
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

**Objective**
Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

**Content**

**Lecture notes**
yes

**Number** 151-0604-00L

**Title** Microrobotics

**Type** W

**ECTS** 4 credits

**Hours** 3G

**Lecturers**
B. Nelson

**Abstract**
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

**Objective**
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

**Content**
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

**Lecture notes**
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdt files. Several readings will also be made available electronically.

**Prerequisites / notice**
The lecture will be taught in English.

**Number** 263-5001-00L

**Title** Introduction to Finite Elements and Sparse Linear System Solving

**Type** W

**ECTS** 4 credits

**Hours** 2V+1U

**Lecturers**
P. Arbenz

**Abstract**
The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that a typical for the FE method. We will consider direct and iterative methods.

**Objective**
Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.
I. THE FINITE ELEMENT METHOD

(1) Introduction, model problems.

(2) 1D problems. Piecewise polynomials in 1D.

(3) 2D problems. Triangulations. Piecewise polynomials in 2D.

(4) Variational formulations. Galerkin finite element method.

(5) Implementation aspects.

II. DIRECT SOLUTION METHODS

(6) LU and Cholesky decomposition.

(7) Sparse matrices.

(8) Fill-reducing orderings.

III. ITERATIVE SOLUTION METHODS

(9) Stationary iterative methods, preconditioning.

(10) Preconditioned conjugate gradient method (PCG).

(11) Incomplete factorization preconditioning.

(12) Multigrid preconditioning.

(13) Nonsymmetric problems (GMRES, BiCGstab).

(14) Indefinite problems (SYMMLQ, MINRES).

Literature


Prerequisites / notice

Prerequisites: Linear Algebra, Analysis, Computational Science.
The exercises are made with Matlab.


Abstract

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Objective

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Content


Practical and theoretical exercises in small groups in the laboratory.

Lecture notes

Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

AND

https://www1.ethz.ch/lbb/Education/BME

Biomedical Engineering


Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.


Practical and theoretical exercises in small groups in the laboratory.

AND

https://www1.ethz.ch/lbb/Education/BME
The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics through practical computer and programming exercises.

The practical work is aimed at training the student's capability to apply and connect specific skills acquired during the MAS specialization. The practical work is designed to train the students in the solution of a specific problem and provides insights in the field of the selected MAS specialization. Tutors propose the subject of the project, the project plan, and the roadmap together with the student, as well as monitor the overall execution.

Only for MAS in Medical Physics

The course language is English.

### Practical Work

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Abstract

The practical work is designed to train the students in the solution of a specific problem and provides insights in the field of the selected MAS specialization. Tutors propose the subject of the project, the project plan, and the roadmap together with the student, as well as monitor the overall execution.

Objective

The practical work is aimed at training the student's capability to apply and connect specific skills acquired during the MAS specialization program towards the solution of a focused problem.

### Electives

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<tr>
<td>151-0605-00L</td>
<td>Nanosystems</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>A. Stemmer, J.N. Tisserant</td>
</tr>
</tbody>
</table>

Abstract

From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures. Special emphasis on the emerging field of molecular electronic devices.

Objective

Familiarize students with basic science and engineering principles governing the nano domain.

Content

The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

Topics are treated in 2 blocks:

(I) From Quantum to Continuum

From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale

Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures.

Literature


Prerequisites / notice

Course format:

Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

Homework: Mini-Reviews

Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

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<tbody>
<tr>
<td>227-0391-00L</td>
<td>Medical Image Analysis</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. C. Cattin, M. A. Reyes Aguirre</td>
</tr>
</tbody>
</table>

Abstract

It is the objective of this lecture to introduce the basic concepts used in Medical Image Analysis. In particular the lecture focuses on shape representation schemes, segmentation techniques, and the various image registration methods commonly used in Medical Image Analysis applications.

Objective

This lecture aims to give an overview of the basic concepts of Medical Image Analysis and its application areas.

Basic knowledge of computer vision would be helpful.

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<td>W</td>
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<td>M. Stampanoni, P. A. Kaestner</td>
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Abstract

From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures. Special emphasis on the emerging field of molecular electronic devices.

Special emphasis is placed on the emerging field of molecular electronic devices, their working principles, applications, and how they may be assembled.

Topics are treated in 2 blocks:

(I) From Quantum to Continuum

From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale

Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures.

Literature


Prerequisites / notice

Course format:

Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

Homework: Mini-Reviews

Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation.

Objective
Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

Content
Synchrontron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes
Available online

Literature
Will be indicated during the lecture.

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227-0967-00L Computational Neuroimaging Clinic

Abstract
This seminar teaches problem solving skills for computational neuroimaging, based on joint analyses of neuroimaging and behavioural data. It deals with a wide variety of real-life problems that are brought to this meeting from the neuroimaging community at Zurich, e.g. mass-univariate and multivariate analyses of fMRI/EEG data, or generative models of fMRI, EEG, or behavioural data.

Objective
1. Consolidation of theoretical knowledge (obtained in the following courses: 'Methods & models for fMRI data analysis', 'Translational Neuroimaging', 'Computational Psychiatry) in a practical setting.

Content
This seminar teaches problem solving skills for computational neuroimaging, based on joint analyses of neuroimaging and behavioural data. It deals with a wide variety of real-life problems that are brought to this meeting from the neuroimaging community at Zurich, e.g. mass-univariate and multivariate analyses of fMRI/EEG data, or generative models of fMRI, EEG, or behavioural data.

Prerequisites
The participants are expected to have successfully completed at least one of the following courses:
- 'Methods & models for fMRI data analysis',
- 'Translational Neuroimaging',
- 'Computational Psychiatry'

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227-0969-00L Methods & Models for fMRI Data Analysis

Abstract
This course teaches methods and models for fMRI data analysis, covering all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, statistical inference, multiple comparison corrections, event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data.

Objective
1. Acquisition of practical problem solving strategies for computational modeling of neuroimaging data.

Content
This course teaches methods and models for fMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, frequentist and Bayesian inference, multiple comparison corrections, and event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data. A particular emphasis of the course will be on methodological questions arising in the context of studies in psychiatry, neurology and neuroeconomics.

Prerequisite: Successful completion of course "Methods & Models for fMRI Data Analysis" (227-0969-00L).

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376-1279-00L Virtual Reality in Medicine

Abstract
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (audiovisual, haptic, tactile etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Objective
Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation.

Content
Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Target Group:
- Students of higher semesters and PhD students of
- D-HEST, D-NAV, D-ITET, D-INFK, D-PHYS
- Robotics, Systems and Control Master
- Biomedical Engineering/Movement Science and Sport
- Medical Faculty, University of Zurich
- Students of other departments, faculties, courses are also welcome!

Literature

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402-0674-00L Physics in Medical Research: From Atoms to Cells

Abstract
Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the Ewald equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to sort cells, to study cell proliferation and metabolism, and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

### Major in Bioengineering

#### Core Courses

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<td>4 credits</td>
<td>3G</td>
<td>M. Stampanoni, P. A. Kaestner</td>
</tr>
<tr>
<td>376-1103-00L</td>
<td>Frontiers in Nanotechnology</td>
<td>W</td>
<td>4 credits</td>
<td>4V</td>
<td>V. Vogel, further lecturers</td>
</tr>
<tr>
<td>376-1714-00L</td>
<td>Biocompatible Materials</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>K. Maniura, J. Möller, M. Zenobi-Wong</td>
</tr>
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Objective

The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

Objective

Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

Content

Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high brilliance and high-colinearity of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes

Available online

Literature

Will be indicated during the lecture.

### Lecture notes

All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.
Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to the Clinics.
6. Biology and Malign Applications. Do Life Sciences Enable the Development of Biological Weapons?
7. Functional Food. Enjoy your Meal!

Content
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecturers

Literature
- (available online via ETH library)

Handouts provided during the classes and references therin.

636-0003-00L Biological Engineering and Biotechnology W 6 credits 3V M. Fussenegger

Abstract
Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Objective
1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to the Clinics.
6. Biology and Malign Applications. Do Life Sciences Enable the Development of Biological Weapons?
7. Functional Food. Enjoy your Meal!

Prerequisites / notice
- All students should have a solid background in molecular biology and biotechnology. This includes knowledge about gene expression, protein engineering, and cell culture techniques.

Lecture notes
Handouts can be accessed online.

Handouts provided during the classes and references therin.

465-0800-00L Practical Work O 4 credits external organisers

Abstract
The practical work is designed to train the students in the solution of a specific problem and provides insights in the field of the selected MAS specialization. Tutors propose the subject of the project, the project plan, and the roadmap together with the student, as well as monitor the overall execution.

Objective
The practical work is aimed at training the student’s capability to apply and connect specific skills acquired during the MAS specialization program towards the solution of a focused problem.


Objective
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.
Content

Lecture notes
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

AND

https://www1.ethz.ch/lbb/Education/BME

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
<th>Type</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-1101-00L</td>
<td>Biomineralization</td>
<td>2</td>
<td>W</td>
<td>K.H. Ernst</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course addresses undergraduate and graduate students interested in getting introduced into the basic concepts of biomineralization.</td>
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<tr>
<td>Objective</td>
<td>The course aims to introduce the basic concepts of biomineralization and the underlying principles, such as supersaturation, nucleation and growth of minerals, the interaction of biomolecules with mineral surfaces, and cell biology of inorganic materials creation. An important part of this class is the independent study and the presentation of original literature from the field.</td>
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<tr>
<td>Content</td>
<td>Biomineralization is a multidisciplinary field. Topics dealing with biology, molecular and cell biology, solid state physics, mineralogy, crystallography, organic and physical chemistry, biochemistry, dentistry, oceanography, geology, etc. are addressed. The course covers definition and general concepts of biomineralization (BM) / types of biominerals and their function / crystal nucleation and growth / biological induction of BM / control of crystal morphology, habit, shape and orientation by organisms / strategies of compartmentalization / the interface between biomolecules (peptides, polysaccharides) and the mineral phase / modern experimental methods for studying BM phenomena / inter-, intra, extra- and epicellular BM / organic templates and matrices for BM / structure of bone, teeth (vertebrates and invertebrates) and mollusk shells / calcification / silification in diatoms, radiolaria and plants / calcium and iron storage / impact of BM on lithosphere and atmosphere / evolution / taxonomy of organisms.</td>
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<tr>
<td></td>
<td>3) P. M. Dove, J. J. DeYoreo, S. Weiner (Eds.) Biomineralization, Reviews in Mineralogy &amp; Geochemistry Vol. 54, 2003</td>
<td></td>
<td></td>
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<tr>
<td>Notice</td>
<td>Each attendee is required to present a publication from the field. The selection of key papers is provided by the lecturer. No special requirements are needed for attending. Basic knowledge in chemistry and cell biology is expected.</td>
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<tr>
<td>376-1622-00L</td>
<td>Practical Methods in Tissue Engineering</td>
<td>5</td>
<td>W</td>
<td>K. Würzt-Kozak, M. Zenobi-Wong</td>
</tr>
<tr>
<td>Abstract</td>
<td>The goal of this course is to teach MSc students the necessary skills for doing research in the fields of tissue engineering and regenerative medicine.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Practical exercises and demonstrations on topics including sterile cell culture, light microscopy and histology, protein and gene expression analysis, and viability assays are covered. The advantages of 3D cell cultures will be discussed and practical work on manufacturing and evaluating hydrogels and scaffolds for tissue engineering will be performed in small groups. In addition to practical lab work, the course will teach skills in data acquisition/analysis.</td>
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<tr>
<td>402-0674-00L</td>
<td>Physics in Medical Research: From Atoms to Cells</td>
<td>6</td>
<td>W</td>
<td>B. K. R. Müller</td>
</tr>
<tr>
<td>Abstract</td>
<td>Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.</td>
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The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

**535-0423-00L**

**Drug Delivery and Drug Targeting**

**Objective**

The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand the field in terms of scientific criteria.

**Content**

The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

**Lecture notes**

Selected lecture notes, documents and supporting material will be directly provided or may be downloaded using http://www.galenik.ethz.ch/teaching/drug_del_drug_targ

**Literature**


Further references will be provided in the course.

**551-1295-00L**

**Introduction to Bioinformatics: Concepts and Applications**

**Abstract**

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

**Objective**

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

**Content**

Bioinformatics I will cover the following topics:

- From genes to databases and information BLAST searches
- Prediction of gene function and regulation RNA structure prediction
- Gene expression analysis using microarrays Protein sequence and structure databases
- WWW for bioinformatics Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 950 of 1571
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

The lecture will be taught in English.

### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Nelson</td>
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<tr>
<td>Abstract</td>
<td>Microrobotics is an interdisciplinary</td>
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<tr>
<td></td>
<td>field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.</td>
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<td>Objective</td>
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<tr>
<td>Content</td>
<td>Main topics of the course include:</td>
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<td></td>
<td>- Scaling laws at micro/nano scales</td>
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<td></td>
<td>- Electrostatics</td>
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<td>- Electromagnetism</td>
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<td></td>
<td>- Low Reynolds number flows</td>
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<td></td>
<td>- Observation tools</td>
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<td></td>
<td>- Materials and fabrication methods</td>
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<tr>
<td></td>
<td>- Applications of biomedical microrobots</td>
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<td>Lecture notes</td>
<td>The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.</td>
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<tr>
<td>Prerequisites</td>
<td>The lecture will be taught in English.</td>
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</table>

| 227-0386-00L   | Biomedical Engineering                  | W    | 4    | 3G    | J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong |
| Abstract       | Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations. |
| Objective      | Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations. |
| Lecture notes  | Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino |
| Prerequisites  | AND |

https://www1.ethz.ch/ibb/Education/BME

| 227-1037-00L   | Introduction to Neuroinformatics        | W    | 6    | 2V+1U | K. A. Martin, M. Cook, V. Mante, M. Pfeiffer |
| Objective      | Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocularities of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enigmas and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions. |
| Content        | This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks. |

| 376-1714-00L   | Biocompatible Materials                 | W    | 4    | 3G    | K. Maniura, J. Möller, M. Zenobi-Wong |
| Abstract       | Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced. |
| Objective      | The class consists of three parts:      |      |      |       |                                    |
|                | 1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials. |
|                | 2. The concept of biocompatibility.     |      |      |       |                                    |
|                | 3. Introduction into methodology used in biomaterials research and application. |
| Content        | Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed. In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers. |
Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will change the way we do science and result in so many new technologies.

Objective

The practical work is aimed at training the student's capability to apply and connect specific skills acquired during the MAS specialization program towards the solution of a focused problem. staircases and nano-systems, from physics to biology. Students will start to appreciate the extent to which scientific change the way we do science and result in so many new technologies.

Objective

The practical work is designed to train the students in the solution of a specific problem and provides insights in the field of the selected MAS specialization. Tutors propose the subject of the project, the project plan, and the roadmap together with the student, as well as monitor the overall execution.

Objective

The practical work is aimed at training the student's capability to apply and connect specific skills acquired during the MAS specialization program towards the solution of a focused problem.

Prerequisites / notice

Particular: The course is highly recommended for those who intend to take the spring semester course 'Neuromorphic Engineering II', that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

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Particular: The course is highly recommended for those who intend to take the spring semester course 'Neuromorphic Engineering II', that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

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Prerequisites: Background in basics of semiconductor physics helpful, but not required.
Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived, to finally discussing biomedical applications and potential health risk issues. Scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

**Objective**

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

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Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

**Content**

1. Theoretical Concepts
   - Features of mass and thermal transport on the microscale
   - Key scaling laws
2. Microfluidic Device Manufacture
   - Conventional lithographic processing of rigid materials
   - Soft lithographic processing of plastics and polymers
   - Mass fabrication of polymeric devices
3. Unit operations and functional components
   - Analytical separations (electrophoresis and chromatography)
   - Chemical and biological synthesis
   - Sample pre-treatment (filtration, SPE, pre-concentration)
   - Molecular detection
4. Design Workshop
   - Design of microfluidic architectures for PCR, distillation & mixing
5. Contemporary Applications in Biological Analysis
   - Microarrays
   - Cellular analyses (single cells, enzymatic assays, cell sorting)
   - Proteomics
6. System integration
   - Applications in radiochemistry, diagnostics and high-throughput experimentation

**Lecture notes**

Lecture handouts, background literature, problem sheets and notes will be provided electronically.

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**529-0837-00L**  
**Biomicrofluidic Engineering**  
W 7 credits 3G A. de Mello

**Abstract**

Microfluidics describes the behaviour, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale. The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.

Number of participants limited to 30.

**Objective**

Specific topics in the course include, but not limited to:

1. Theoretical Concepts
2. Microfluidic Device Manufacture
3. Unit operations and functional components
4. Design Workshop
5. Contemporary Applications in Biological Analysis
6. System integration

---

**636-0003-00L**  
**Biological Engineering and Biotechnology**  
W 6 credits 3V M. Fussenegger

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of survival pathways to increase robustness of production cell lines. Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocolourites of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematicians, statisticians and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Objective
- Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
- The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
- Everything Under Control I. Regulated Transgene Expression in Mammalian Cells - Facts and Future.
- Secretion Engineering. The Traffic Jam getting out of the Cell.
- From Target To Market. An. Antibody’s Journey From Cell Culture to The Clinics.
- Development of Biological Weapons?
- Functional Food. Enjoy your Meal!
- IP Management - Food Technology, Protecting Your Knowledge For Business.
- Biopharmaceutical Manufacturing I. Introduction to Process Development.
- Biopharmaceutical Manufacturing II. Upstream Development.
- Biopharmaceutical Manufacturing IV. Pharma Development.

Abstract
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Content
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

Practical Work
The practical work is aimed at training the students in the solution of a specific problem and provides insights in the field of the selected MAS specialization. Tutors propose the subject of the project, the project plan, and the roadmap together with the student, as well as monitor the overall execution.

Objective
- The practical work is designed to train the students in the solution of a specific problem and provides insights in the field of the selected MAS specialization. Tutors propose the subject of the project, the project plan, and the roadmap together with the student, as well as monitor the overall execution.

Lecturer Notes
Handsout during the course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1037-00L</td>
<td>Introduction to Neuroinformatics</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>K. A. Martin, M. Cook, V. Mante, M. Pfeiffer</td>
</tr>
<tr>
<td>465-0800-00L</td>
<td>Practical Work Only for MAS in Medical Physics</td>
<td>O</td>
<td>4 credits</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>
The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques will be discussed and their use in daily research, in particular biology, is presented. The course gives an introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications. This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

### Electives

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1033-00L</td>
<td>Neuromorphic Engineering I</td>
<td>W</td>
<td>6 credits</td>
<td>2V+3U</td>
<td>T. Delbrück, G. Indiveri, S.C. Liu</td>
</tr>
</tbody>
</table>

**Abstract**

This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

**Objective**

Understanding of the characteristics of neuromorphic circuit elements.

**Content**

Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

**Literature**

S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

**Prerequisites / notice**

Particular: The course is highly recommended for those who intend to take the spring semester course 'Neuromorphic Engineering II', that teaches the conception, simulation, and physical layout of such circuits with chip design tools. Prerequisites: Background in basics of semiconductor physics helpful, but not required.

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1795-00L</td>
<td>Advanced Course in Neurobiology I (Functional Anatomy of the Rodent Brain) (University of Zurich)</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>J.M. Fritschy, H. U. Zeilhofer</td>
</tr>
</tbody>
</table>

**Abstract**

The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.

**Objective**

This credit point course is designed for doctoral students who have successfully completed the Introductory Course in Neuroscience at the Neuroscience Center Zürich. The goal is to provide students with a broader and deeper knowledge in several important areas of neurobiology.

**Prerequisites / notice**


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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-1791-00L</td>
<td>Introductory Course in Neuroscience I (University of Zurich)</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>J.M. Fritschy, W. Knecht</td>
</tr>
</tbody>
</table>

**Abstract**

The course gives an introduction to human and comparative neuroanatomy, molecular, cellular and systems neuroscience.

**Objective**

The course gives an introduction to human and comparative neuroanatomy, molecular, cellular and systems neuroscience.

**Content**

1) Human Neuroanatomy I&II
2) Comparative Neuroanatomy
3) Development I&II
4) Membran and Action Potential
5) Synaptic Transmision & Plasticity I&II
6) Glia and Bloddi-Brain-BARRIER
7) Somatosensory and Motor System
8) Visual System
9) Auditory System
10) Circuits underlying Emotion
11) Modeling of Neural Circuits

**Prerequisites / notice**

For doctoral students of the Neuroscience Center Zurich (ZNZ).

### Major in Biocompatible Materials

#### Core Courses

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0965-00L</td>
<td>Micro and Nano-Tomography of Biological Tissues</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Stampanoni, P. A. Kaestner</td>
</tr>
</tbody>
</table>

**Abstract**

The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics. The lecture teaches the conception, simulation, and physical layout of such circuits with chip design tools.
Content

Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes

Will be indicated during the lecture.

Literature

Available online

Number
376-1622-00L

Title
Practical Methods in Tissue Engineering

Type
W

ECTS
5 credits

Hours
4P

Lecturers
K. Würtz-Kozak, M. Zenobi-Wong

Abstract

Number of participants limited to 12.

Objective

Practical exercises and demonstrations on topics including sterile cell culture, light microscopy and histology, protein and gene expression, and cell biology of inorganic materials creation. An important part of the practical work is aimed at training the student's capability to apply and connect specific skills acquired during the MAS specialization.

Content

The class consists of three parts:

1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes

Handouts can be accessed online.

Literature


(available online via ETH library)

Practical Work

Handouts provided during the classes and references therein.

Electives

The course addresses undergraduate and graduate students interested in getting introduced into the basic concepts of biominalization. The course aims to introduce the basic concepts of biominalization and the underlying principles, such as supersaturation, nucleation and growth of minerals, the interaction of biomolecules with mineral surfaces, and cell biology of inorganic materials creation. An important part of this class is the independent study and the presentation of original literature from the field.
Biominalization is a multidisciplinary field. Topics dealing with biology, molecular and cell biology, solid state physics, mineralogy, crystallography, organic and physical chemistry, biochemistry, dentistry, oceanography, geology, etc. are addressed. The course covers definition and general concepts of biominalization (BM)/ types of biominalers and their function / crystal nucleation and growth / biological induction of BM / control of crystal morphology, habit, shape and orientation by organisms / strategies of compartmentalization / the interface between biomolecules (peptides, polysaccharides) and the mineral phase / modern experimental methods for studying BM phenomena / inter-, intra, extra- and epicellular BM / organic templates and matrices for BM / structure of bone, teeth (vertebrates and invertebrates) and mollusk shells / calcification / silification in diatoms, radiolaria and plants / calcium and iron storage / impact of BM on lithosphere and atmosphere/ evolution / taxonomy of organisms.

1. Introduction and overview
2. Biominerals and their functions
3. Chemical control of biomineralization
4. Control of morphology: Organic templates and additives
5. Modern methods of investigation of BM
6. BM in matrices: bone and nacre
7. Vertebrate teeth
8. Invertebrate teeth
9. BM within vesicles: calcite of coccoliths
10. Silica
11. Iron storage and mineralization

Lecture notes
Script with more than 600 pages with many illustrations will be distributed free of charge.

Literature
3) P. M. Dove, J. J. DeYoreo, S. Weiner (Eds.) Biomineralization, Reviews in Mineralogy & Geochemistry Vol. 54, 2003

Prerequisites / notice
Each attendee is required to present a publication from the field. The selection of key papers is provided by the lecturer. No special requirements are needed for attending. Basic knowledge in chemistry and cell biology is expected.
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

★★★ Major in Molecular Biology and Biophysics

★★★★ Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0945-00L</td>
<td>Cell and Molecular Biology for Engineers I</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>C. Frei</td>
</tr>
<tr>
<td></td>
<td>This course is part I of a two-semester course.</td>
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</table>

Abstract

The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

Objective

After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

Content

Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytokoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publictions will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.

Lecture notes

Scripts of all lectures will be available.

Literature


551-1295-00L

Introduction to Bioinformatics: Concepts and Applications

<table>
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<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>W. Gruissem, K. Bärenfaller, A. Caflisch, G. Captiani, J. Fütterer, M. Robinson, A. Wagner</td>
</tr>
</tbody>
</table>

Abstract

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications in bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Objective

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms* that will be offered in the following semester.
Content: Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

ECTS Type: Biomineralization

G. Wider, F. Allain

2V+1U

This lecture course targets physics students and students of interdisciplinary sciences (major physics) for their education in biophysics. In Frontiers in Nanotechnology

Biophysics of Biological Macromolecules

The course will only take place with a minimum of 4 participants.

Abstract: This lecture course targets physics students and students of interdisciplinary sciences (major physics) for their education in biophysics. In this course the basics of molecular biology are presented bearing in mind the special interests of the physics students.

Objective: Basics of molecular biology and biophysics in in view of the special interest of students in physics.

Content: This lecture course targets physics students and students of interdisciplinary sciences (major physics) for their education in biophysics. In this course the basics of molecular biology are presented bearing in mind the special interests of the physics students. The topics include: properties of biological macromolecules, introduction to the genetic system of E. coli bacteria, transcription, translation, discussion of structure and function of proteins, and biomineralization.

Lecture notes: - additional documentation in support of text book

Prerequisites / notice: small classes with active participation of students

#### Practical Work

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>465-0800-00L</td>
<td>Practical Work</td>
<td>O</td>
<td>4</td>
<td></td>
<td>external organisers</td>
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</table>

**Abstract:** The practical work is designed to train the students in the solution of a specific problem and provides insights in the field of the selected MAS specialization. Tutors propose the subject of the project, the project plan, and the roadmap together with the student, as well as monitor the overall execution.

**Objective:** The practical work is aimed at training the student’s capability to apply and connect specific skills acquired during the MAS specialization program towards the solution of a focused problem.

#### Electives

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>327-1101-00L</td>
<td>Biomineralization</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>K.H. Ernst</td>
</tr>
</tbody>
</table>

**Abstract:** The course addresses undergraduate and graduate students interested in getting introduced into the basic concepts of biomineralization.

**Objective:** The course aims to introduce the basic concepts of biomineralization and the underlying principles, such as supersaturation, nucleation and growth of minerals, the interaction of biomolecules with mineral surfaces, and cell biology of inorganic materials creation. An important part of this class is the independent study and the presentation of original literature from the field.

**Content:** Biomineralization is a multidisciplinary field. Topics dealing with biology, molecular and cell biology, solid state physics, mineralogy, crystallography, organic and physical chemistry, biochemistry, dentistry, oceanography, geology, etc. are addressed. The course covers definition and general concepts of biomineralization (BM)/ types of biominerals and their function / crystal nucleation and growth / biological induction of BM / control of crystal morphology, habit, and shape by biomineralization / the interface between biomolecules (peptides, polysaccharides) and the mineral phase / modern experimental methods for studying BM phenomena / inter-, intra, and extra- cellular BM / organic templates and matrices for BM / structure of bone, teeth (vertebrates and invertebrates) and mollusk shells / re-crystallization / silification in diatoms, radiolaria and plants / calcium and iron storage / impact of BM on lithosphere and atmosphere/ evolution / taxonomy of organisms.

1. Introduction and overview
2. Biominerals and their functions
3. Chemical control of biomineralization
4. Control of morphology: Organic templates and additives
5. Modern methods of investigation of BM
6. BM in matrices: bone and nacre
7. Vertebrate teeth
8. Invertebrate teeth
9. BM within vesicles: calcite of coccoliths
10. Silica
11. Iron storage and mineralization

**Lecture notes:** Script with more than 600 pages with many illustrations will be distributed free of charge.

**Literature:**
3) P. M. Dove, J. J. DeYoreo, S. Weiner (Eds.) Biomineralization, Reviews in Mineralogy & Geochemistry Vol. 54, 2003

**Prerequisites / notice:** Each attendee is required to present a publication from the field. The selection of key papers is provided by the lecturer. No special requirements are needed for attending. Basic knowledge in chemistry and cell biology is expected.

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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-1103-00L</td>
<td>Frontiers in Nanotechnology</td>
<td>W</td>
<td>4</td>
<td>4V</td>
<td>V. Vogel, further lecturers</td>
</tr>
</tbody>
</table>

**Abstract:** Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.
Objective

Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.

The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Each lecturer will first give an overview of the state-of-the art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

Content

Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived, finally discussing biomedical applications and potential health risk issues.

Scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

Lecture notes

All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

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402-0674-00L

**Physics in Medical Research: From Atoms to Cells**

**W**

**6 credits**

**2V+1U**

B. K. R. Müller

Abstract

Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

Objective

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunnelling microscopy (STM) and atomic force microscopy (AFM). The combination of STM and beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure’s shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only used in atomic and inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue’s anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.
Abstract
The course consists of a series of research seminars on Structural Biology, Biochemistry and Biophysics, given by both scientists of the National Center of Competence in Research (NCCR) in Structural Biology and external speakers. Information on the individual seminars is provided on the following websites:
http://www.structuralbiology.uzh.ch/educ002.asp
http://www.biol.ethz.ch/dbiol-cal/index

Objective
The goal of this course is to provide doctoral and postdoctoral students with a broad overview on the most recent developments in biochemistry, structural biology and biophysics.

551-0307-00L Molecular and Structural Biology I: Protein Structure and Function

D-BIOL BSc students are obliged to take part I and part II (next semester) as a two-semester course

Abstract
Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

Objective
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

Lecture notes
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

Literature
Basics:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.

636-0003-00L Biological Engineering and Biotechnology

Abstract
Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Objective
1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to the Clinics.
6. Biology and Malign Applications. Do Life Sciences Enable the Development of Biological Weapons?
7. Functional Food. Enjoy your Meal!

Lecture notes
Handsout during the course.

MAS in Medical Physics - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Q</th>
<th>W+</th>
<th>W</th>
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<tbody>
<tr>
<td></td>
<td>Compulsory</td>
<td>Eligible for credits and recommended</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>Courses outside the curriculum</td>
<td>Suitable for doctorate</td>
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Key for Hours

<table>
<thead>
<tr>
<th>Key for Hours</th>
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<th>G</th>
<th>U</th>
<th>S</th>
<th>K</th>
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<tbody>
<tr>
<td></td>
<td>lecture</td>
<td>lecture with exercise</td>
<td>exercise</td>
<td>seminar</td>
<td>colloquium</td>
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<td>P</td>
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<td>R</td>
<td>revision course / private study</td>
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ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
**Lectures and Seminars**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>115-0511-00L</td>
<td>Lecture Week 11: Introduction Study Project 2 ■</td>
<td>W</td>
<td>1</td>
<td>1G</td>
<td>A. Grams Dietziker</td>
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<tr>
<td></td>
<td>Only for MAS in Spatial Planning.</td>
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<td></td>
<td>The topic of the study project of the second year is the question of spatial development over large areas in the Lake of Constance region. Typical problems in such a kind of spaces are the complexity of content and institutions; two days excursion in the project area; consolidation of the methodology for interdisciplinary team work.</td>
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<td></td>
<td>The aim of the first course in the second year of the program is an individual setting up of the further education; developing an overview on the second Study Project as well as reviewing the basic knowledge about team work gathered in the first year and adapting it if necessary in the second year.</td>
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<tr>
<td>115-0512-00L</td>
<td>Lecture Week 12: Spatial Development ■</td>
<td>W</td>
<td>2</td>
<td>1G</td>
<td>B. Scholl</td>
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<tr>
<td></td>
<td>Only for MAS, DAS and CAS in Spatial Planning.</td>
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<td></td>
<td>In this course, the fundamental methods in spatial planning taught in the second week will be consolidated. In particular additional knowledge and practice in the fields of spatial planning methodology, spatial design and argumentation will be given in lectures and case studies.</td>
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<td></td>
<td>The aim of the lecture is the consolidation and the practice of important methodic principles in spatial planning. They provide also a base for working on the second Study Project of the MAS program.</td>
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<tr>
<td>115-0513-00L</td>
<td>Lecture Week 13: Urban Planning and Urban Design II ■</td>
<td>W</td>
<td>2</td>
<td>1G</td>
<td>K. Christiaanse, S. Kretz</td>
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<td>Only for MAS, DAS and CAS in Spatial Planning.</td>
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<td>The second week on urban design and urban planning focuses on a case study in the field of strategic urban design. The course includes a field trip, discussions with actors from the planning and design professional field and a workshop. Students analyse and discuss a real life problem and elaborate proposals for a suitable urban design strategy.</td>
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<td>The aim of the course is an in-depth understanding of contemporary urban design challenges and an exemplary, case-based experience of elaborating adequate urban design strategies.</td>
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<tr>
<td>115-0514-00L</td>
<td>Lecture Week 14: Spatial Planning: Theory and Methodology ■</td>
<td>W</td>
<td>2</td>
<td>1G</td>
<td>W. Schönwandt, A. Grams Dietziker</td>
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<td>Only for MAS, DAS and CAS in Spatial Planning.</td>
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<td></td>
<td>Impart thinking patterns and active application of fundamentals of planning theories and methods. In the centre are plausibility and rigour of the line of arguments in spatial planning. From the statement of the problem to analysis of the source of the problem to formulation of sustainable solutions; development of different planning steps considering communication theory and ethics.</td>
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<td>Appropriate and constructive application of the examined thinking patterns and planning steps; transfer according to task and situation to new planning problems.</td>
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<tr>
<td>115-0515-00L</td>
<td>Lecture Week 15: Academic Working in Spatial Planning ■</td>
<td>W</td>
<td>2</td>
<td>1G</td>
<td>A. Grams Dietziker, R. Nebel</td>
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<td>Only for MAS, DAS and CAS in Spatial Planning.</td>
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<td></td>
<td>What means a scientific method in spatial planning?; methods for clarification processes; basic knowledge of scientific working and writing; various case studies and exercises.</td>
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<td>Knowledge for a scientific way of working; structuring a scientific paper using the example of the exposé or MAS-Thesis.</td>
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<tr>
<td>115-0516-00L</td>
<td>Lecture Week 16: Spatial Planning: European Aspects ■</td>
<td>W</td>
<td>2</td>
<td>1G</td>
<td>O. Damsgaard</td>
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<td>Only for MAS, DAS and CAS in Spatial Planning.</td>
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<td>Introduction to European planning systems and their evolution since the 1990s; good planning practice under different conditions across Europe; the European Union and the territorial development policy; team work on different cases.</td>
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<td>How to analyse and compare different national planning systems; how to identify potentials for spatial planning.</td>
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**Projects and Individual Work**

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>115-0702-00L</td>
<td>Study Project 2 (part 1) ■</td>
<td>O</td>
<td>0</td>
<td>10U</td>
<td>S. Gatti-Sauter, F. Günther,</td>
</tr>
<tr>
<td></td>
<td>Only for MAS in Spatial Planning.</td>
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<td>K. H. Hoffmann-Bohner, D. L. Kolb,</td>
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<td></td>
<td>Development of strategies for sustainable development in the Lake Constance region: spatial planning analysis of the situation (goals and problems, potentials and risks, strengths and weaknesses); concept design (goals and measures); program development (objective and temporal priorities); preparation for implementation (instruments and procedures). Independent group work.</td>
<td></td>
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<td></td>
<td>P. J. Noser, R. Tremp</td>
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<tr>
<td></td>
<td>Detect, assess and classify the main conflicts of spatial development and define the need for planning action. Concentrate resources and design; evaluate different solutions and demonstrate their feasibility exemplarily. Recognize possibilities and limits of formal and informal planning and apply them in practice. Efficient and interdisciplinary work in groups, using optimally individual knowledge and skills of each group member.</td>
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**MAS in Spatial Planning - Key for Type**

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<td>Recommended, not eligible for credits</td>
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<tr>
<td>W+</td>
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<td>W</td>
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<td></td>
<td>Suitable for doctorate</td>
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### Key for Hours

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<td>V</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>R</td>
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</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Sustainable Water Resources

The Master of Advanced Studies in Sustainable Water Resources is a 12 month full time postgraduate diploma programme. The focus of the programme is on issues of sustainability and water resources in Latin America, with special attention given to the impacts of development and climate change on water resources. The programme combines multidisciplinary coursework with high-level research. Sample research topics include: water quality, water quantity, water for agriculture, water for the environment, adaptation to climate change, and integrated water resource management. Language: English. Credit hours: 66 ECTS.

For further information please visit: http://www.ifu.ethz.ch/MAS_SWR

Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>118-0101-00L</td>
<td>Water Resources Seminars</td>
<td>O</td>
<td>3</td>
<td>3S</td>
<td>P. Molnar, P. Burlando, further speakers</td>
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<tr>
<td></td>
<td>Number of participants limited to 16. Automatic admittance given to the MAS students.</td>
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Abstract
The Seminar Series features invited experts from a wide range of disciplines, who will present their experiences working with water related topics in international settings. The students will be exposed to many different perspectives, and will be asked to apply the information they learn to specific case studies.

Objective
The Seminar Series will provide students with background information on the wide range of topics related to water resources. The lectures will challenge the students to evaluate water resources and water resource management in new ways, using tools that have been successfully implemented in real case scenarios. The seminars will include theory, interactive discussions, and the assessment of methodologies. Student participation will be highly encouraged.

Content
The Seminar Series is aimed at offering students the opportunity to learn about water resources in a multi-disciplinary fashion, with a focus on international examples. Selected topics will include: Water & Sanitation, Urban Water Management, Politics & International Water Management, Water Resources & Agriculture, Water Hazards (floods), Water Resources & Ecosystem Services, Integrated Water Resource Management, and Adaptation to Climate Change. For additional details see the course website http://www.mas-swr.ethz.ch/education/courses/core-courses/water-resources-seminars.html.

Prerequisites / notice
For further information, contact the MAS coordinator, Darcy Molnar (darcy.molnar@ifu.baug.ethz.ch).

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0287-00L</td>
<td>Fluvial Systems</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>P. Molnar</td>
</tr>
</tbody>
</table>

Abstract
The course presents a view of the processes acting on and shaping the landscape and the fluvial landforms that result. The fluvial system is viewed in terms of the production and transport of sediment on hillslopes, the structure of the river network and channel morphology, fluvial processes in the river, riparian zone and floodplain, and basics of catchment and river management.

Objective
The course has two fundamental aims: (1) it aims to provide environmental engineers with the physical process basis of fluvial system change, using the right language and terminology to describe landforms; and (2) it aims to provide quantitative skills in making simple and more complex predictions of change and the data and models required.

Content
The course consists of three sections: (1) Introduction to fluvial forms and processes and geomorphic concepts of landscape change, including climatic and human activities acting on the system. (2) The processes of sediment production, upland sheet-riparian erosion, basin sediment yield, rainfall-triggered landsliding, sediment budgets, and the modelling of the individual processes involved. (3) Processes in the river, floodplain and riparian zone, including river network topology, channel geometry, aquatic habitat, role of riparian vegetation, including basics of fluvial system management. The main focus of the course is hydrological and the scales of interest are field and catchment scales.

Lecture notes
There is no script.

Literature
The course materials consist of a series of 13 lecture presentations and notes to each lecture. The lectures were developed from textbooks, professional papers, and ongoing research activities of the instructor. All material is on the course webpage.

Prerequisites / notice
Prerequisites: Hydrology I and Hydrology 2 (or contact instructor).

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>P. Burlando, S. Fatichi</td>
</tr>
</tbody>
</table>

Abstract
The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

Objective
Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.

Content
Monitoring of hydrological systems (point and space monitoring, remote sensing). The use of GIS in hydrology (practical applications).

Lecture notes
Parts of the script for "Hydrology I" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

Literature
Additional literature is presented during the course.

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>101-0267-01L</td>
<td>Numerical Hydraulics</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Holzner</td>
</tr>
</tbody>
</table>

Abstract
In the course Numerical Hydraulics the basics of numerical modelling of flows are presented.

Objective
The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.

Content
The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modeling are also treated.

All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

Lecture notes
Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

Literature
Given in lecture

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>103-0237-00L</td>
<td>GIS III</td>
<td>O</td>
<td>5</td>
<td>3G</td>
<td>M. Raubal</td>
</tr>
</tbody>
</table>

Abstract
The course deals with advanced topics in GIS; GIS project lifecycle, Managing GIS, Legal issues, GIS assets & constraints; Geospatial Web Services; technical basics, architecture, functions, interoperability, standards, mashups, portals, applications; Geostatistics; Sensor Web Enablement; Human-Computer Interaction; Cognitive Issues in GIS.

Objective
Students will get a detailed overview of advanced GIS topics. They will go through all steps of setting up a Web-GIS application in the labs and perform other practical tasks related to Sensor Web Enablement, Human-Computer Interaction, Geostatistics, and Web Processing Services.

Lecture notes
Lecture slides will be made available in digital form.
The course is structured as follows:

- Introduction into modeling and simulation
- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controllers, fuzzy control)

Content
The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:

- Introduction into modeling and simulation
- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controllers, fuzzy control)

Lecture notes
Copies of overheads will be made available.

Literature
There will be a required textbook that students need to purchase:

Prerequisites / notice
This course will be offered together with the course Process Engineering Ia. It is advantageous to follow both courses simultaneously.
enrol 102-0327-01 Advanced Environmental Assessments (2KP) as already included in 102-0307-01 Advanced Environmental, Social and Economic Assessments (5KP).

Abstract
How to make sustainability operational - in industry, services and other organizations: You will learn how to put sustainability into practice by integrating environmental, social and economic aspects into organisations' management and processes. The course contains both a management view, as well as a sustainability view - and how to combine them.

Objective
To provide understanding of how sustainability can be made operational in an organisation. To do so, students will understand how to integrate sustainability thinking into the typical current organisational environment and processes, such as planning, implementing and controlling.

Content
We meet for five 3-hour-lectures, with discussions and case studies during course time. Additionally, small case studies in-between courses will be given at most course days.

Course topics are:
- Sustainable Development and its meaning for Management
- Management Standards for Sustainability (ISO and others)
- Sustainability Opportunities and Innovation
- Organisation and Implementation
- The concept of 'Continuous Improvement'
- Environmental Performance Measurement (Concepts, Standards, Methods)
- Life Cycle Costing, Life Cycle Management
- (Sustainable) Supply Chain Management
- Communication of Sustainability Issues

Lecture notes
Course documentation as well as case study descriptions will be provided during the course via the "Ilias" repository.

Literature
There are two ways to approach the course's issues:


c) We will touch upon the hotel sustainable scheme and label "ibex" see: http://www.e2mc.com/images/stories/e2_bilder/downloads/Umweltfocus_d.pdf (for an english version, pls contact the lecturer at arthurb@ethz.ch)

Prerequisites / notice
If you have specific interests or questions, let me know at arthurb@ethz.ch. Maybe I can include your issues - or I can't :-)

Electives

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<th>Number</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0215-00L</td>
<td>Urban Water Management II</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Maurer, P. Staufer</td>
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<tr>
<td>401-6215-00L</td>
<td>Using R for Data Analysis and Graphics (Part I)</td>
<td>W</td>
<td>1</td>
<td>1G</td>
<td>A. Drewek, A. J. Papritz</td>
</tr>
</tbody>
</table>

Abstract

Objective
Consolidation of the basic procedures for design and operation of technical networks in water engineering.

Content
Demand Side Management versus Supply Side Management
Optimierung von Wasserverteilnetzen
Druckstösse
Kalkausschlick, Korrosion von Leitungen
Hygiene in Verteilsystemen
Siedlungshydrologie: Niederschlag, Ablauflüssigkeit
Instationäre Strömungen in Kanalisationen
Stofftransport in der Kanalisation
Einleitbedingungen bei Regenwetter
Versickerung von Regenwasser
Generelle Entwässerungsplanung (GEP)

Lecture notes
Written material and copies of the overheads will be available.

Prerequisites / notice
Prerequisite: Introduction to Urban Water Management
Introduction into the theoretical background and the practical application of methods of data analysis in meteorology and climatology.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Note: Part I of UsingR is complemented and extended by Part II, which is offered during the second part of the semester and which can be taken independently from Part I.

Lecture notes
An Introduction to R. http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf

Prerequisites / notice
The course resources will be provided via the Moodle web learning platform. Please login (with your ETH (or other University) username-password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145

Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

651-4077-00L Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)
View graphs used during the lecture

W 3 credits 1V
University lecturers

Abstract
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GED815

Objective
Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges. Discussion of present research challenges.

Content
Erosion and sedimentation by glaciers as a function of topography, englacial temperature, sediment balance, sliding and melt water runoff. Processes and landforms in regions of seasonal and perennial frost (frost weathering, rock falls, debris cones/talus, solifluction, permafrost creep/rock glaciers, debris flows).

Lecture notes
Glacial and periglacial geomorphodynamics in high-mountain regions. Ca. 100 pages.

Literature
- References in skript

701-1341-00L Water Resources and Drinking Water

W 3 credits 2G
S. Hug, M. Berg, F. Hammes, U. von Gunten

Abstract
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

Objective
The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Content
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Lecture notes
Handouts will be distributed

Literature
Will be mentioned in handouts

701-1253-00L Analysis of Climate and Weather Data

W 3 credits 2G
C. Frei

Abstract
Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

Objective
Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

Content
Introduction into the theoretical background and the practical application of methods of data analysis in meteorology and climatology. Topics: exploratory methods, hypothesis tests, analysis of climate trends, measuring the skill of climate and forecasting models, analysis of extreme events, principal component analysis and maximum covariance analysis.

The lecture also provides an introduction into R, a programming language and graphics tool frequently used for data analysis in meteorology and climatology. During hands-on computer exercises the student will become familiar with the practical application of the methods.

Lecture notes
Documentation and supporting material include:
- documented view graphs used during the lecture
- exercise sets and solutions
- R-packages with software and example datasets for exercise sessions

All material is made available via the lecture web-page.

Literature
Suggested literature:
### Land-Climate Dynamics 701-1251-00L

**Prerequisites / notice**

Prerequisites: Atmosphäre, Mathematik IV: Statistik, Anwendungsnahes Programmieren.

**Abstract**

The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

**Objective**

The students can understand the role of land processes and associated feedbacks for the climate system.

**Lecture notes**

Powerpoint slides will be made available.

**Prerequisites / notice**

Lectures and slides are available at [this link](http://www.vvz.ethz.ch/Vorlesungsverzeichnis/lerneinheitPre.do?lerneinheitId=57794&semkez=2009S&lang=en).

### Physics of Glaciers 651-4101-00L

**Prerequisites / notice**

Good high school mathematics and physics knowledge required.

**Abstract**

Understanding glaciers and ice sheets with simple physical concepts. Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, glacier seismology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.

**Objective**

After the course the students are able understand and interpret measurements of ice flow, subglacial water pressure and ice temperature. They will have an understanding of glaciology-related physical concepts sufficient to understand most of the contemporary literature on the topic. The students will be well equipped to work on glacier-related problems by numerical modeling, remote sensing, and field work.

**Content**

The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).

**Lecture notes**

A list of relevant literature is available on the class web site.

**Literature**

[This link](http://people.ee.ethz.ch/~luethim/teaching.html)

### Limnology 701-1437-00L

**Prerequisites / notice**

This course can only be taken together with "701-1437-01 Bestimmungskurs aquatische Makroinvertebraten" and "701-1437-02 Bestimmungskurs aquatische Mikroinvertebraten und Kryptogamen".

**Abstract**

This course combines Limnology (the study of inland waters in its broad sense) with ecological and evolutionary concepts. It deals with rivers, groundwater and lakes.

This course contains a lecture part, an experimental part as well as 1-day excursions.

During this course you will get an overview of the world's typical freshwater ecosystems. After this course you will be able to understand how aquatic organisms have adapted to their habitat and how the interactions (e.g. food web) between organisms work.

During the experimental part of this course you will learn the principles of doing research to observe interrelations in aquatic ecosystems. You will measure and interpret biological and physical data (e.g. during experiments, field work) and present the collected knowledge.

In short: apply the theoretical / lecture knowledge to field situations in a lake and river.

**Objective**

During this course you will get an overview of the world's typical freshwater ecosystems. After this course you will be able to understand how aquatic organisms have adapted to their habitat and how the interactions (e.g. food web) between organisms work.

**Content**

The lecture part covers ecology and evolution of aquatic organisms in lentic and lotic waters. Topics include: Adaptations, distribution patterns, biotic interactions, and conceptual paradigms in freshwater ecosystems. Important aspects regarding ecosystem metabolism and habitat properties of freshwaters. Applied case studies and experiments testing ecological and evolutionary processes in freshwaters.

The practical part contains 1-day excursions to a lake (Greifensee) and rivers (Sense, Töss) as well as research projects in small groups within research groups at Eawag.

The course contains a lecture part, an experimental part and field excursions.

**Lecture notes**

Course notes and power point presentations provided during the course.

**Prerequisites / notice**

This course is mandatory for students majoring in Aquatic Ecology. The course includes mandatory field trips to Greifensee (22.09.2016), to the Sense River floodplain (6.10.2016) and to the Töss River (20.10.2016).

### Foundations of Ecosystem Management 701-1631-00L

**Abstract**

This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

**Objective**

Students should be able to

a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.

b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.
Content

Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasize the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

Lecture notes
No Script

Literature

701-0727-00L Politics of Environmental Problem Solving in Developing Countries

W 2 credits 2G U Scheidegger

Abstract
The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.

Objective
After completion of the module, students will be able to:
- Identify and appraise ecological aspects in development cooperation, development policies and developing countries’ realities
- Analyze the forces, components and processes, which influence the debates, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

Content
Key issues and basic concepts related to environmental politics are introduced. Then the course predominantly builds on case studies, providing information on the context, specifying problems and potentials, describing processes, illustrating the change management, discussing experiences and outcomes, successes and failures. The analysis of the cases elucidates factors for success and pitfalls in terms of processes, key elements and intervention strategies.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008
- Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

Lecture notes
Information concerning the case studies and specific issues illustrated therein will be provided during the course (uploaded on Moodle)

Literature

Prerequisites / notice
The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the resources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology

W 3 credits 2G+2U D, Or

Abstract
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Objective
Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges
I. Hajnsek

First readings for the course:
Handouts for each topic will be provided

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical
background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily
work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear
modeling.

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media Units and dimensions, definitions and basic mass-volume relationships
between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay
behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and
time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components;
properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations
and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements;
parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its
measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.;
approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting
front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and
estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface
evaporation.

Week 12 to 13: Solute Transport in Soils Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion
eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter
estimation.

Additional topics:
Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal
properties; engineering applications.

Biological Processes in the Vadose Zone An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between
physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Financial


Lecture notes
Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller
(available at the beginning of the semester)
http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Lecture notes
Handouts for each topic will be provided

Lecture notes
First readings for the course:
Complete literature listing will be provided during the course.

Literature
Supplemental textbook (not mandatory) -Environmental Soil Physics, by: D. Hillel

Lecture notes

102-0617-00L
Basics and Principles of Radar Remote Sensing for W 3 credits 2G I. Hajnsek
Environmental Applications

Abstract
The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging
techniques for the use of environmental parameter estimation.

Objective
The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation.
At the end of the course the student has the understanding of
1. SAR basics and principles,
2. SAR polarimetry,
3. SAR interferometry and
4. environmental parameter estimation from multi-parametric SAR data

Content
The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different
environmental applications. The outline of the course is the following:
1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano
monitoring, forest height inversion, wood biomass estimation etc.)

401-0649-00L
Applied Statistical Regression W 5 credits 2V+1U M. Dettling

Abstract
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical
background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily
work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear
modeling.

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The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multilinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

**Lecture notes**
A script will be available.

**Literature**
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

**Prerequisites / notice**
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

**701-1644-00L Mountain Forest Hydrology**

**W** 5 credits  
3G  
J. W. Kirchner

**Abstract**
This course presents a process-based view of the hydrology, biogeochemistry, and geomorphology of mountain streams. Students learn how to integrate process knowledge, data, and models to understand how landscapes regulate the fluxes of water, sediment, nutrients, and pollutants in streams, and to anticipate how streams will respond to changes in land use, atmospheric deposition, and climate.

**Objective**
Students will have a broad understanding of the hydrological, biogeochemical, and geomorphological functioning of mountain catchments. They will practice using data and models to frame and test hypotheses about connections between streams and landscapes.

**Content**
Streams are integrated monitors of the health and functioning of their surrounding landscapes. Streams integrate the fluxes of water, solutes, and sediment from their contributing catchment area; thus they reflect the spatially integrated hydrological, ecophysiological, biogeochemical, and geomorphological processes in the surrounding landscape. At a practical level, there is a significant public interest in managing forested upland landscapes to provide a reliable supply of high-quality surface water and to minimize the risk of catastrophic flooding and debris flows, but the scientific background for such management advice is still evolving.

Using a combination of lectures, field exercises, and data analysis, we explore the processes controlling the delivery of water, solutes, and sediment to streams, and how those processes are affected by changes in land cover, land use, and climate. We review the connections between process understanding and predictive modeling in these complex environmental systems. How well can we understand the processes controlling watershed-scale phenomena, and what uncertainties are unavoidable? What are the relative advantages of top-down versus bottom-up approaches? How much can “black box” analyses reveal about what is happening inside the black box?

Conversely, can small-scale, micro-mechanistic approaches be successfully “scaled up” to predict whole-watershed behavior? Practical problems to be considered include the effects of land use, atmospheric deposition, and climate on streamflow, water quality, and sediment dynamics, illustrated with data from experimental watersheds in North America, Scandinavia, and Europe.

**Lecture notes**
Handouts will be available as they are developed.

**Literature**
Recommended and required reading will be specified at the first class session (with possible modifications as the semester proceeds).

**Master’s Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>118-0121-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>24 credits</td>
<td>51D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Students propose relevant research topics from their home countries, or from Latin American research projects, around which individual study programmes are devised, and on which they write their thesis. The Master thesis is supervised by scientific staff at ETH and collaborating institutions, and is based on the student's academic or professional experience.

**Objective**
The Master Thesis research takes place throughout the duration of the MAS Programme (12 months), complemented by Master level coursework and Seminars focusing on Water Resources and Sustainability. Students become familiar with new research techniques, and receive guidance from experts. The topic of the research should address a relevant water resources problem in the student’s home country, and is aimed at enhancing collaboration between academics and professionals in Latin America and in Switzerland.

**MAS in Sustainable Water Resources - Key for Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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**Key for Hours**

<table>
<thead>
<tr>
<th>Letter</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

**ECTS**
European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
## MAS in Urban Design

### Courses Offered

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>065-0070-00L</td>
<td><strong>MAS Programme “Urban Transformation in Developing Territories”</strong></td>
<td>E-</td>
<td>0 credits</td>
<td>16S</td>
<td>M. Angéil</td>
</tr>
</tbody>
</table>

**Abstract**

The MAS programme is structured around an investigation of transforming urban conditions as they pertain to global phenomena, and the development of practical tools for operating within such domains.

**Objective**

The programme aims at developing a culture of urban research and design that will enable the participant to actively engage in envisioning future urban scenarios. Secondly, a strong emphasis is put on methodology, process design and communication in order to prepare for the interdisciplinary negotiating agenda of the urban designer as future member of professional design offices, academic research teams, public services or communication agencies.

**Content**

Each year, the MAS studio will focus on two specific topics of urban research and two existing sites on which to intervene in the form of two design research studios. The sites are preferably territories under development pressure with existing groups of urban actors to engage with.

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### Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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### Key for Hours

<table>
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<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
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<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.

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Autumn Semester 2016

Data: 06.11.2018 12:57
Management, Technology and Economics (General Courses)

General Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>351-0778-00L</td>
<td>Discovering Management</td>
<td>Z</td>
<td>3</td>
<td>3G</td>
<td>B. Clarysse, M. Ambühl, S. Brusoni, E. Fleisch, G. Grote, V. Hoffmann, P. Schönsleben, G. von Krogh, F. von Wangenheim</td>
</tr>
</tbody>
</table>

Abstract: Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Objective: Discovering Management combines in an innovative format a set of lectures and an advanced business game. The learning model for Discovering Management involves 'learning by doing'. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow.

This business case is as relevant to someone exploring innovation within an organization as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.

Content: Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the interdependence of various topics in the development and management of a firm. The lectures introduce students not only to topics relevant for managing large corporations, but also touch upon the different aspects of starting up your own venture. The lectures will be presented by the respective area specialists at D-MTEC.

Prerequisites: No prior knowledge of business or economics is required to successfully complete this course.

Please refer to the course website for further information on the content, credit conditions and schedule of the module: www.dm.ethz.ch
Managerial Economics applies economic theory and methods to business and economic decision-making. Economic ideas related to optimization, the theory of consumer demand, the theory of the firm, industrial organization and decision making under uncertainty are studied using methods of numerical analysis, statistical estimation, game theory and constrained optimization.

The objective of the course is to provide undergraduate and graduate students in MAVT with an understanding of the use of economic concepts for firm-level management decisions. The course covers a number of models and methods of analysis which are commonly employed in business decisions. The course covers the economic theory of choice, models of oligopoly and industrial organization, applications of game theory to contract design and agency theory, and the theory of decision making under uncertainty focusing specifically on long-term investment decisions. The course will include three lectures by Professor Volker Hoffman focusing on related case-studies in management.

The course acquaints students who have previous not studied economics to economic concepts and quantitative methods which can be used to solve management decision problems.

The course introduces ESOP (Excellence Scholarship & Opportunity Programme) Fellows to leadership in the business world. After a preparatory seminar that builds foundations in theory and methods, the fellows 'shadow' top-managers and observe their work-routines for several days.

Observations are later analyzed amongst the students and in a personal debriefing with managers to allow for mutual reflections on leadership.

The participants develop deep insights into a company as they follow a senior manager or a member of the Board of Directors for several days as a 'shadow'. They learn by experiencing leadership in action and later offer their reflections to the executives, thereby creating opportunities for mutual learning. The course gives students an introduction to theories of leadership and methods to observe leadership practices. Students will record their impressions in field journals. The intensive shadowing phase is prepared in a two-day bloc seminar and de-briefed in a one-day reflection workshop. At a common event with ETH Foundation and participating companies, selected reflections by ESOP fellows are presented to a larger audience.

A central aim and learning objective of the course is that students reflect deeply about responsibilities and challenges in the practice of leadership and refine their critical thinking skills. The course is an innovative contribution to intergenerational learning and a stimulus to the development of the students' personalities towards becoming confident entrepreneurs of the next generation.

<table>
<thead>
<tr>
<th>Management, Technology and Economics (General Courses) - Key for Type</th>
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<tbody>
<tr>
<td>O</td>
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<tr>
<td>W+</td>
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<td>Dr</td>
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<td>E-</td>
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<table>
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<tr>
<th>Key for Hours</th>
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<tr>
<td>V</td>
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ECTS | European Credit Transfer and Accumulation System
---|---
| Special students and auditors need special permission from the lecturers.
Core Courses

General Management and Human Resource Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0341-00L</td>
<td>Introduction to Management</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>S. Brusoni, P. Baschera</td>
</tr>
</tbody>
</table>

Abstract
This course is an introduction to the critical management skills involved in planning, structuring, controlling and leading an organization.

Objective
We develop a ‘systemic’ view of organizations.
We look at organizations as part of an industry context, which is affected by different elements like strategy, structure, culture, tasks, people and outputs.
We consider how managerial decisions are made in any one of these domains affect decisions in each of the others.

Content
Further information is available on the Tim Group Chair's website: http://www.timgroup.ethz.ch/en/courses
and on the Moodle of the course: https://moodle-app2.let.ethz.ch/course/view.php?id=2209
(The Enrollment Key to Moodle will be provided during the course)

Lecture notes
The content of the course will rely on the book:

Prerequisites / notice
All the materials uploaded on Moodle must be considered as required readings.

Strategy, Technology and Innovation Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-0387-00L</td>
<td>Corporate Sustainability</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>V. Hoffmann</td>
</tr>
</tbody>
</table>

Abstract
The lectures addresses the assessment of corporate sustainability and its links to strategy, technology, and finance. Students learn why sustainability matters for managers and how businesses can act towards it. E-modules allow students to train critical thinking skills. In the 2nd half of the semester, sustainability challenges on water, energy, mobility, and food are explored in group projects.

Objective
Understand the limits and the potential of corporate sustainability for sustainable development

Content
Business implications of sustainable development, in particular for the assessment of sustainability performance, strategic change towards sustainability, technological innovations and sustainability, and finance and corporate sustainability.
Critical thinking skills for corporate sustainability.
In-depth case studies of corporate sustainability challenges in the track phase: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze technological innovations for sustainability? How to invest money in a sustainable way?

Lecture notes
Presentation slides will be made available on Moodle prior to lectures.

Literature
Literature recommendations will be distributed during the lecture

363-0389-00L Technology and Innovation Management W+ 3 credits 2G S. Brusoni

Abstract
This course focuses on the analysis of innovation as a pervasive process that cut across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.

Objective
This course intends to enable all students to:
- understand the core concepts necessary to analyze how innovation happens
- master the most common methods and tools organizations deploy to innovate
- develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation

Content
This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success are small.
How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course is focused, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.

Lecture notes
Slides will be available on the TIMGROUP website.

Literature
Readings will be available on the TIMGROUP website.

Prerequisites / notice
No specific background in economics or management is required.

363-0392-00L Strategic Management W+ 3 credits 2G G. von Krogh

Registration through myStudies (first come, first served). If you are unable to sign up through myStudies, please

A. After the lecture, the student is able to evaluate digital business models from different angels, including theory-based views:

- an investor (should I invest in start-up xy?)
- an entrepreneur (should I pursue this venture?)
- a decision maker in an established company (should I invest in project A or B?)
- an investor (should I invest in start-up xy?)

B. The student knows different tools to design digital business model patterns.
Content
Uber, Airbnb, Nest and Jawbone - A wide range of innovative companies exist, which successfully implemented ICT enabled business models and continue to grow at a rapid pace. Examples, illustrating how digitalization, including the "Internet of Things" currently fosters business model innovation across various industries. This course is designed to help students to understand and critically assess such newly emerging (digital) business models.

For the lecture students will get access to one of the leading online teaching platforms (called edX) also offered by other top universities (incl. MIT, Harvard, Berkeley, etc.). Using the edX platform, will allow students to collaborate in online discussions, solve online exercises and present a short educational video as part of a group project.

Key Topics:
- Business model innovation; (digital) business model patterns; business value of IT; the concept of integration; transaction cost perspective.
- Network economics perspective; essentials and impact of web 2.0; internet of things, mobile computing, market places, social analytics and big data; IT governance and portfolio management; entrepreneurship in the digital space, etc.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>363-0445-00L</td>
<td>Production and Operations Management</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>T. Netland, P. Schönsleben</td>
</tr>
<tr>
<td>363-0453-00L</td>
<td>Strategic Supply Chain Management</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>S. Wagner</td>
</tr>
</tbody>
</table>

Abstract
This core course on Production and Operations Management provides the students insights into the basic theories, principles, concepts, and techniques used to design, analyze, and improve the operational capabilities of an organization.

Objective
Students learn why and how operations can be a competitive weapon; how to design, plan, control, and manage production and service processes; how to improve effectiveness and efficiency in operations; how to take advantage of new technological advancements; and how environmental and social concerns affect decisions in global production networks.

Content
The course covers the most fundamental strategic and tactical concepts in production and operations management. The lectures cover: Introduction to POM; Operations strategy; Capacity management; Production planning and control; Production philosophies; Lean management; Performance measurement; Problem solving; Service operations; New technologies in POM; Servitization; Global production; and Triple-bottom line.

Literature

363-0305-00L Empirical Methods in Management

Abstract
Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.

Objective
- Ability to formulate research questions and designing an appropriate study
- Ability to collect and analyze data using a variety of methods
- Ability to critically assess the quality of empirical research in management
- Applied knowledge of empirical methods through out-of-class assignments

Content
1) Introduction to empirical management research
2) Research designs: exploratory, descriptive, experimental
3) Measurement and scaling
4) Data collection and sampling
5) Data analysis methods
6) Reporting and presenting empirical research

Prerequisites / notice
Assignments and projects: This course includes out-of-class assignments and projects to give students some hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. Students will have at least one week to work on each assignment. Students are expected to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned-in on time.

Class participation: Class participation is encouraged and can greatly improve students’ learning in this class. In this spirit, students are expected to attend class regularly and come to class prepared.

Quantitative and Qualitative Methods

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-0305-00L</td>
<td>Empirical Methods in Management</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>A. Scherer</td>
</tr>
<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>W+</td>
<td>3</td>
<td>3G</td>
<td>F. Schweitzer, G. Casiraghi, V. Nanumyan</td>
</tr>
</tbody>
</table>

Abstract
Finding solutions: what is complexity, problem solving cycle.

Implementing solutions: project management, critical path method, quality control feedback loop.

Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption

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A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear systems and apply this to macroeconomic dynamics

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (oscillating dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.

Lecture notes: The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

Prerequisites / notice: Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

363-1004-00L Operations Research

Abstract: This course provides an introduction to operations research methods in the fields of management science and economics. Requisite mathematical concepts are introduced with a practical, problem-solving perspective.

Objective:
- Introduction to building and using quantitative models in a business / industrial environment
- Introduction to basic optimization techniques (Linear Programming and extensions, network flows, integer programming, dynamic and stochastic optimization)
- Understanding the integration of quantitative models into the managerial decision process

Content: The following topics are covered: Systems and models, linear models and the importance of linear programming, duality theory and shadow prices, integer programming, optimization under uncertainty and applications in inventory management.

Lecture notes: A printed script will be made available.

Literature: Any standard textbook in Operations Research is a useful complement to the course.

Prerequisites / notice: Undergraduate calculus, linear algebra, probability and statistics are a prerequisite.

The course introduces basic principles, problems and approaches of microeconomics.

The learning objectives of the course are:
(1) Students must be able to discuss basic principles, problems and approaches in microeconomics. (2) Students can analyse and explain simple economic principles in a market using supply and demand graphs. (3) Students can contrast different market structures and describe firm and consumer behaviour. (4) Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole. (5) Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.

Lecture notes: Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature: N. Gregory Mankiw and Mark P. Taylor (2014), "Microeconomics", 3rd edition, South-Western Cengage Learning. The book can also be used for the course 'Principles of Microeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:

Complementary:

Resource and Environmental Economics

Abstract: Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.
Objective

Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:

- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

Content

- Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes

Learning material and script can be found here: https://moodle-app2.let.ethz.ch/course/view.php?id=328

Literature


363-0565-00L Principles of Macroeconomics

Abstract

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?

Objective

This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to everyday economic problems.

Content

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer. Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

Lecture notes

The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2467) contains announcements, course information and lecture slides.

Literature


We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

Financial Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>363-0561-00L</td>
<td>Financial Market Risks</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>D. Sornette</td>
</tr>
</tbody>
</table>

Abstract

I aim to introduce students to the concepts and tools of modern finance and to make them understand the limits of these tools, and the many problems met by the theory in practice. I will put this course in the context of the ongoing financial crises in the US, Europe, Japan and China, which provide fantastic opportunities to make the students question the status quo and develop novel solutions.
Objective

The course explains the key concepts and mechanisms of financial economics, their depth and then stresses how and why the theories and models fail and how this is impacting investment strategies and even a global view of citizenship, given the present developing crises in the US since 2007 and in Europe since 2010.

- Development of the concepts and tools to understand these risks and master them.
- Working knowledge of the main concepts and tools in finance (Portfolio theory, asset pricing, options, real options, bonds, interest rates, inflation, exchange rates)
- Strong emphasis on challenging assumptions and developing a systemic understanding of financial markets and their many dimensional risks

Content

1- The Financial Crises: what is really happening? Historical perspective and what can be expected in the next decade(s). Bubbles and crashes. The illusion of the perpetual money machine.

2- Risks in financial markets
- What is risk?
- Measuring risks of financial assets
- Introduction to three different concepts of probability
- History of financial markets, diversification, market risks

3- Introduction to financial risks and its management.
- Relationship between risk and return
- Portfolio theory: the concept of diversification and optimal allocation
- How to price assets: the Capital Asset Pricing Model
- How to price assets: the Arbitrage Pricing Theory, the factor models and beyond

4- Financial markets: role and efficiency
- What is an efficient market?
- Financial markets as valuation engines: exogeneity versus endogeneity (reflexivity)
- Deviations from efficiency: puzzles and anomalies in the financial markets
- Financial bubbles, crashes, systemic instabilities

5- An introduction to Options and derivatives
- Calls, Puts and Shares and other derivatives
- Financial alchemy with options (options are building blocks of any possible cash flow)
- Determination of option value: concept of risk hedging

6- Valuation and using options
- A first simple option valuation model
- The Binomial method for valuing options
- The Black-scholes model and formula
- Practical examples and implementation
- Realized prices deviate from these theories: volatility smile and real option trading
- How to imperfectly hedge with real markets?

7- Real options
- The value of follow-on investment opportunities
- The timing option
- The abandonment option
- Flexible production
- Conceptual aspects and extensions

8- Government bonds and their valuation
- Relationship between bonds and interest rates
- Real and nominal rates of interest
- Term structure and Yields to maturity
- Explaining the term structure
- Different models of the term structure

9- Managing international risks
- The foreign exchange market
- Relations between rates and interest rates, inflation, and other economic variables
- Hedging currency risks
- Currency speculation
- Exchange risk and international investment decisions

Lecture notes

Lecture slides will be available on the site of the lecture

Literature

Corporate finance
Brealey / Myers / Allen
Eighth edition

+ Additional paper reading provided during the lectures

Prerequisites / notice

none

363-0711-00L

Accounting for Managers
W+ 3 credits 2V M. Passardi

Overview of financial and managerial accounting
Accounting for current and fixed assets
Liabilities and owners equity
Recording change in balance sheet
Measuring financial performance
Managing financial reporting
Full and variable costing system
Using accounting information for decision making purposes

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Objective
Understand the different procedures involved in the accounting system
Record change in financial position
Measure business income
Prepare final accounts
Understand the principles of cost accounting
Calculate the different product costs
Make decisions about the acceptance or rejection of a particular product

Content
Financial Accounting: Balance sheet, income statement, double-entry accounting, journal and ledger, accounting for merchandising activities, value-added tax, adjustments before final accounts, provisions, depreciation, valuation,

Managerial Accounting: Full costing, variable costing, cost-volume-profit, break-even analysis, activity-based costing

Prerequisites / notice
This course is a prerequisite for the course Financial Management.

Electives

Recommended Elective Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-0301-00L</td>
<td>Work Design and Organizational Change</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>G. Grote</td>
</tr>
<tr>
<td>Abstract</td>
<td>Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>- Know effects of work design on competence, motivation, and well-being</td>
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</tr>
<tr>
<td>Content</td>
<td>- Understand links between design of individual jobs and work processes</td>
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<tr>
<td></td>
<td>- Know basic processes involved in systematic organizational change</td>
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<td>- Understand the interaction between organization and technology and its impact on organizational change</td>
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<td></td>
<td>- Understand relevance of work design for company performance and strategy</td>
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<td></td>
<td>- Know and apply methods for analyzing and designing work</td>
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<tr>
<td>Literature</td>
<td>A list of required readings will be provided at the beginning of the course.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course includes the completion of a course project to be conducted in groups of four students. The project entails applying a particular method for analyzing and designing work processes and is carried out by means of interviews and observations in companies chosen by the students.</td>
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| 363-0301-00L| Psychological Aspects of Risk Management and Technology | W    | 3    | 2V    | G. Grote, J. Schmutz, R. Schneider, M. Zumbühl |
| Abstract    | Using uncertainty management by organizations and individuals as conceptual framework, risk management and risk implications of new technologies are treated. Three components of risk management (risk identification/evaluation, risk mitigation, risk communication) and underlying psychological and organizational processes are discussed, using company case studies to promote in-depth understanding. |
| Objective   | - understand basic components of risk management in organizations |      |      |       |                                  |
| Content     | - know psychological foundations of risk perception, decision-making under risk, and risk communication |      |      |       |                                  |
| Literature  | The syllabus includes the following topics: Elements of risk management - risk identification and evaluation - risk mitigation - risk communication Psychological and organizational concepts relevant in risk management - decision-making under uncertainty - risk perception - resilient organizational processes for managing uncertainty Case studies on different elements of risk management (e.g., rule making, training, managing project risks, automation) Group projects related to company case studies |
| Prerequisites / notice | There is no script, but slides will be made available before the lectures. |
| Literature  | There are texts for each of the course topics made available before the lectures. |
| Prerequisites / notice | The course is restricted to 40 participants who will work closely with the lecturers on case studies prepared by the lecturers on topics relevant in their own companies (Swiss Re, Skyguide, Swisscom). |

| 363-0393-00L| Corporate Strategy | W    | 3    | 2V    | S. Ben-Menahem |
| Abstract    | Due to didactic considerations, the number of participants for this course is limited to 50. Please register through myStudies to enroll for the course. Slots are assigned on a first-come first-serve basis (in the order of the registration date on myStudies). We will confirm your registration by e-mail. If you have any inquiries about the course, please contact the course assistant. |
| Content     | This course focuses on the challenges in managing multi-business corporations, and covers topics related to the vertical and horizontal scope of business activities. |
|            | 70% of the final grade consists of a final closed-book written exam and 30% of the final grade will consist of individual/group assignments. |
Overview how the world has developed. Understanding the role of innovation for economic growth. Design of policies to foster innovation.

The course Corporate Strategy draws from a wide range of theories and methods to develop an understanding of the conceptual frameworks, debates, and developments concerning decisions associated with the management of multi-business corporations. We will cover the key questions driving a firm's corporate strategy, including:

- In what markets to compete with which businesses?
- Which activities should be performed by the firm and which should be outsourced (i.e. "make" or "buy" decisions)?
- What are the most appropriate approaches to growth and divestiture?
- How do institutional forces impact corporate strategy?

Specifically, we will examine how organizations manage their portfolio of business activities and markets to achieve competitive advantage through vertical integration, cooperative strategies such as strategic alliances and joint ventures, corporate diversification, mergers and acquisitions, divestitures, and globalization/international strategies, and strategic renewal.

Format:

The course is a combination of lectures about concepts/methods, guest lectures, case studies/assignments, and group debates/assignments.

Content

The course homepage can be found at: http://www.smi.ethz.ch/education/courses/corporatestategy

Prerequisites / notice

Having participated in the course Strategic Management by Prof. Georg von Krogh/Dr. Zeynep Erden is an advantage but not a requirement.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>W</th>
<th>credits</th>
<th>2G</th>
<th>T. Gutzwiller</th>
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<tbody>
<tr>
<td>363-0425-00L</td>
<td>Transformation: Corporate Development and IT</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>T. Gutzwiller</td>
</tr>
</tbody>
</table>

Abstract

The lecture treats the main challenges of business transformation and the alignment of corporate development and IT activities. It presents a holistic approach to business transformation projects by introducing an integrated model dealing with three main design areas "strategy”, “processes” and “information systems” and applying this model to various case studies.

Objective

The goal of the lecture is to understand the main challenges of corporate transformation and to demonstrate the application of a holistic project procedure model for corporate transformation projects with special emphasis on the alignment of business and IT.

Content

The globalization of the world leads to an increasingly faster pace in business transformation. Enterprises have to adapt faster and even faster to the environmental changes in a global economy to remain competitive and to make sure they stay in business. In todays information age this does not only mean to adapt business strategy and business processes but also to adapt information systems to the new circumstances. The fast adaptation through large scale corporate transformation projects that change strategy, business processes and information systems is critical to ensure competitiveness for tomorrow. The introduction of new business processes and information systems typically takes years in very complex large scale projects. Many projects fail because of insufficient alignment between decision makers in business and IT. Unclear understanding of the overall project scope, undefined roles and responsibilities, unclear project processes, quality problems and resistance to change are some typical problems found in such projects. The lecture is subdivided into following modules:

- Corporate development introduction and motivation,
- Parallelization of corporate development and complexity reduction,
- Planning process and project portfolio management in corporate development,
- Management of large scale projects integration of strategy, processes and information systems,
- Quality management in large scale projects,
- Project management in large scale projects,
- Change management within projects. The lecture is accompanied by four case studies that are used to exemplify the contents of the lecture by applying the concepts to real situations in corporate life.

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>W</th>
<th>credits</th>
<th>2G</th>
<th>M.C. Riekhof</th>
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<tbody>
<tr>
<td>363-0562-01L</td>
<td>Economics of Innovation and Growth</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>M.C. Riekhof</td>
</tr>
</tbody>
</table>

Abstract

Overview how the world has developed. Understanding the role of innovation for economic growth. Design of policies to foster innovation and growth.

Objective

There are three goals of the lecture. First, understanding how the world has developed over the last centuries and the proximate and fundamental causes of economic growth. Second, understanding and application of the basic models of economic growth. Third, design of policies to foster innovation and growth to reduce the large wealth differences in the world.

Content

1. Introduction
2. Neoclassical Growth Theory
3. Innovations and Growth (New Growth Theory)
4. Growth Policy
5. Institutions and Growth

Lecture notes

The transparencies used in the lectures will be distributed to the participants.
Data: 06.11.2018 12:57  Autumn Semester 2016  Page 983 of 1571

Literature
Core literature:

Additional literature:

363-0585-00L Intermediate Econometrics W 3 credits 2V M. Kesina
Abstract
The idea of this course is to familiarize students with instrumental variables estimation of linear regression models and the estimation of models with limited dependent variables as well as of nonlinear regression models. While most of the material covered will pertain to cross-sectional data, we will also work on selected issues with panel data.

Objective
I will provide STATA programs and show the execution thereof. After having participated in this course, students will be able to carry out simple research projects and understand the basics of intermediate econometrics. In particular, they will be able to write simple programs in STATA and to qualify their own and others’ regression output relating to problems covered.

Literature

363-0723-00L Corporate Finance W 3 credits 2G M. Neuhaus
Abstract
Corporate Finance, investment management, business valuation, value based management & compensation, financial reporting today & in future, financial reporting value chain, reporting on non-financial measures, such as corporate sustainability reporting, mergers & acquisitions, legal aspects, taxes, corporate governance - risk management - internal controls & mgmt. information systems, turnaround.

Objective
Introduction in theory and practical application of Corporate Finance, with a particular focus on financing of operations and transactions, analysed from multiple aspects, including legal and tax.

Content
Corporate Finance, investment management, business valuation, value based management and compensation, financial reporting today and in future, financial reporting value chain, reporting on non-financial measures, such as corporate sustainability reporting, mergers and acquisitions, legal aspects, taxes, corporate governance - risk management - internal controls and management information systems, turnaround.

Lecture notes
Slides in English will be available for download on the following website: https://ilias-app2.let.ethz.ch/lias.php?https://ilias-app2.let.ethz.ch/goto.php?target=crs_68655&client_id=ilias_ida

Prerequisites / notice
The lecture will be supported by the Chair of Entrepreneurial Risks. Please refer to the chair's website for more detailed information regarding the course (www.er.ethz.ch/teaching).

363-0887-00L Management Research W 1 credit 1S Z. Erden Özkol
Abstract
The course is mandatory for MSc. students and recommended for MAS students who write their Master Thesis at the Chair of Strategic Management and Innovation. Participation to both sessions are mandatory to receive the credit, there will be no exceptions.

Objective
If a student can’t take part in one of the sessions, the course has to be taken the following semester.

Content
This course teaches students about the basic principles of scientific work in the field of social sciences. The goal is to motivate students to develop an own thesis design and write scientific articles.

Literature
Nicolay Siggelkow (2007) Persuasion with Case Studie AMJ Vol. 50, No. 1

Prerequisites / notice
The course is mandatory for MSc. students and recommended for MAS students who write their Master Thesis at the Chair of Strategic Management and Innovation - those will be served first.
- The course will be given once every semester by Dr. Zeynep Erden Özkol and the PhD students of the chair
- The course takes two days, one for lecture, one for student paper presentations. Participation to both sessions are mandatory to receive the credit, there will be no exceptions.
- Students who participate in the lecture and present a paper receive 1 credit point. The course and the presentations will be given in English.
- Students might benefit more if they take this course towards the end of their studies, before writing their master thesis.
363-1037-00L  
**Fiscal Competition and Multinational Firms**  
W 3 credits 2V  M. Köthenbürger, F. Liberini  

**Abstract**  
The course enables students to understand how multinational firms respond to differential tax regimes in a global economy and how countries strategically use the tax system to host multinationals. In particular, the course covers transfer pricing issues, internal financing decisions and agency problems and their relation to tax policy.

**Objective**  
Understanding how taxes influence decisions of multinational firms

**Using theoretical models and empirical analysis to uncover regularities in how multinational firms respond to taxes**

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363-1044-00L  
**Applied Negotiation Seminar**  
Due to didactics reasons, the number of participants is limited to 30.  

**Prerequisites:** Successful completion of lectures "363-1039-00L Introduction to Negotiation".

**Abstract**  
The block-seminar combines lectures introducing negotiation, negotiation engineering and specific aspects of successful negotiation with the respective application through in-class negotiation case studies and games.

**Objective**  
Students obtain a concentrated insight into key aspects of the field of negotiations, negotiation engineering and specific aspects of successful negotiation. Multiple opportunities to apply that knowledge in different negotiation situations allow for an in-depth learning experience.

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363-1049-00L  
**Contemporary Conflict Management**  
W 3 credits 2V  M. Ambühl, S. C. Zürcher  

**Abstract**  
The course provides students with theoretical background and practical insights in conflict management in the 3 areas international, business and interpersonal (legal) relations. Students are introduced into theoretical concepts related to the research field and real world case studies including examples of international conflicts, WWI, old and new regional conflicts, business and mediation.

**Objective**  
- knowledge of history of conflict management;  
- comprehension of major ideas in the theory and practice of conflict management, mediation, transformation and resolution;  
- application of theoretical concepts to current conflict situations;  
- evaluation of conflict situations in international relations and business.

**Content**  
The following topics will be covered:  
- history of international and regional conflicts;  
- theoretical concepts of conflict management;  
- theoretical models of arms races and conflict escalation;  
- case studies in international conflicts, as well as in business.

**Literature**  
- Peter Wallensteen (2012): Understanding Conflict Resolution. SAGE, London, UK  

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363-1050-00L  
**Power and Leadership**  
W 3 credits 2S  P. Schmid  

**Abstract**  
Students will gain - knowledge of history of conflict management;  
- comprehension of major ideas in the theory and practice of conflict management, mediation, transformation and resolution;  
- application of theoretical concepts to current conflict situations;  
- evaluation of conflict situations in international relations and business.

**Objective**  
Students will - develop thinking about the strategic use of differential tax systems for multinational firms - comprehend of major ideas in the theory and practice of conflict management, mediation, transformation and resolution - application of theoretical concepts to current conflict situations - evaluation of conflict situations in international relations and business.

**Literature**  
- Peter Wallensteen (2012): Understanding Conflict Resolution. SAGE, London, UK  

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363-1051-00L  
**Asset Liability Management and Treasury Risks**  
W 3 credits 2V  P. Mangold, M. Eichhorn  

**Abstract**  
Asset Liability Management (ALM) is the cornerstone of managing the balance sheet of any corporation. The goal of this course is to discuss the foundations and to develop a thorough understanding of the Treasury function, with a particular emphasis on managing the risks relating to ALM.

**Objective**  
We attempt to develop an integrated perspective on financial risks materializing in impacts on capital, earnings, and liquidity. Even though the concepts are generally applicable, the course puts a focus on banking institutions.

The course comprises of three parts, Part 1 introducing the fundamental concepts, Part 2 discussing case studies allowing us to dive more deeply into specific real-world examples, focusing on cases where the risk management has failed, while Part 3 will look at hot topics such as new regulations relating to funding, liquidity, market risk, and capital management. We will also discuss whether regulations are fit for purpose or whether they might have unintended consequences.

This course is interactive and students' participation is an important aspect. To make the classes more lively and interactive, students are expected to complete group assignments and give an inclass presentation.
This part covers fundamental concepts for ALM and Treasury, balance sheet and off-balance sheet products, Basel III capital and liquidity rules, trading and hedging principles, interest rate and FX management, performance metrics (e.g. net interest income, net interest margin), operating model for Treasury and Treasury Risk, ALCOs, liquidity risk management, and funds transfer pricing (FTP).

Part 2: Case Studies
In the second part of the course we are using case studies to analyze real-world examples, allowing us to go into more detail with regards to the fundamental concepts. Particularly, we are focusing on cases of failure, where, for potentially different reasons, corporations have failed and in which ALM has been an important aspect.

Part 3: Hot Topics in ALM and Treasury Risk Management
The last part looks at selected hot topics such as new regulations relating to funding, liquidity, market risk, and capital management. We will also discuss whether regulations are fit for purpose, i.e. whether it contributes to systemic stability, or whether they might have unintended consequences.

Lecture notes
No single textbook covers the course, below we list some useful references. Further materials will be made available to students prior to the lectures.

Literature
- Sethi, A. “From Science to Startup” ISBN 978-3-319-30422-9

Prerequisites / notice
Basic knowledge in finance

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<th>Code</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-1082-00L</td>
<td>Enabling Entrepreneurship: From Science to Startup 1 W</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>A. Sethi</td>
</tr>
</tbody>
</table>
| Students should provide a brief overview (unto 1 page) of their business ideas that they would like to commercialise through the course. If they do not have an idea, they are required to provide a motivation letter stating why they would like to do this elective.

The total number of students in this first batch will be limited to 30. It is preferable that the students already form teams of at least two persons, where both the team-members would like to do the course. The names of the team-members should be provided together with the business idea or the motivation letter submitted by the students.

The students should submit the necessary information and apply before 21st September 2016 to anilsethi@ethz.ch. They will be intimated by 23rd September 2016 to confirm if they have secured a place.

Once the application has been confirmed, a registration in myStudies is possible.

Abstract
Participants form teams and identify an idea, which is then taken through the steps necessary to form a startup. The primary focus of the course is geared to technology startups that want to reach scale.

Objective
Participants want to become entrepreneurs.

The course will enable the students to identify an idea and take all necessary steps to convert it into a company, through the duration of the two semesters.

The participants will have constant exposure to investors and entrepreneurs (with a focus on ETH spin-offs) through the course, to gain an understanding of their vision and different perspectives.

Content
Participants start from idea identification, forming team, technology and market size validation, assessing time-to-market, customer focus, IP strategy & financials, to become capable of starting the company and finally making the pitch to investors.

Literature
- Book
- Sethi, A. “From Science to Startup”

Prerequisites / notice
This course is only relevant for those students who aspire to become entrepreneurs.

Additional Electives Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-0345-01L</td>
<td>Lecture Cycle Purchasing</td>
<td>W</td>
<td>2</td>
<td>1V</td>
<td>S. Wagner</td>
</tr>
</tbody>
</table>

Abstract
This lecture is about practical and theoretical issues in the field of purchasing & supply management. Purchasing managers from various industries examine the importance of purchasing for corporate success. Possible topics of the presentations could be: Corporate and purchasing strategy, supplier networks, innovations in purchasing, supply chain redesign, sustainability in purchasing.

Objective
This lecture is about practical and theoretical issues in the field of purchasing & supply management. Purchasing managers from various industries examine the importance of purchasing for corporate success.

Content
The speakers are executives from purchasing and supply chain management departments as well as from general management. We will discuss recent issues in purchasing and supply management such as: Corporate and purchasing strategy, supplier networks, procurement organization, innovations in purchasing, supply chain redesign, sustainability in purchasing & supply management.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>363-0445-002L</td>
<td>Production and Operations Management (Additional</td>
<td>W</td>
<td>1</td>
<td>2A</td>
<td>T. Netland, P. Schönsleben</td>
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</tbody>
</table>

Additional Electives Courses

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 985 of 1571
Abstract
With the aim of preparing the students to take on managerial responsibility, this 2x5 days-seminar teaches basic and practical management skills.

Objective
To convey management behaviour based on practical examples, own experiences and team discussions complemented by short theory sessions (subsidized from the donation for promotion and training in enterprise sciences at the ETHZ).

Content
1 Fundamentals of Communication Psychology
2 Communication in Business-Life
3 Fundamentals of Leadership
4 Self-Management and Life Balance
5 Leadership Tools
6 Problem Solving and Decision Making Techniques
7 Performance Coaching
8 Conflict Management
9 Personality
10 Summary-Day, Domino-Examination

Lecture notes
Will be provided as electronic version at www.entrepreneurship.ethz.ch at least one week before the seminar starts

Prerequisites / notice
Special permission from lecturers required

Limited number of participants: Mandatory registration required.

IMPORTANT NOTICE
Preliminary announcement: Seminar 2 is offered in Spring Semester 2017. Students can only register and participate in “Seminar 1” OR “Seminar 2”.

Seminar 1: 2 x 5 days
Limited number of participants: Mandatory registration required for “Seminar 1” until 30.06.2016 by E-Mail: bms@ethz.ch
Block I: 15.-19.08.2016, 9-17 h
Block II: 05.-09.09.2016, 9-17 h
where: tba

Seminar 2: 2 x 5 days
Limited number of participants: Mandatory registration required for “Seminar 2” until 26.09.2016 by E-Mail: bms@ethz.ch
Block I: 30.01.-03.02.2017, 9-17 h
Block II: 13.02.-17.02.2017, 9-17 h
where: tba
Learning outcomes professional competence
- The students learn and understand the management basics of inter-firm cooperation and organizational networks (business models, incl. risk, communication, etc.)
- Realize the value creation potentials of alliances (added value)
- Understand underlying theoretical models (Transaction cost theory, principal agent, game theory)
- Identify and understand specific forms of collaboration (Strat. All., JV, Networks, M&A, etc.)
- Apply tools hands on in real companies (in coll. with companies)

Learning outcomes methodological competence
- Writing academic papers
- Developing structured documentation of interviews
- Transferring theory directly into application
- Contributing to the learning journey

Learning outcomes social competence
- Work together with industrial partners
- Improving communication skills as basics for collaboration
- Developing and applying team work skills
- Coping with conflicts resolution in teams

Content
The constantly augmenting complexity of technologies and systems, the increased pressure caused by competition, the need for shortening time-to-market and the thereby implied growing risks force organizations to increasingly focus on core competencies. Collaboration with external partners is a key value creation opportunity for successful ventures. This type of cooperation also has implications on daily management activities. This lecture will provide a better understanding of special requirements needed for management of cooperation issues.

- Introduction to theory and management of inter-firm collaboration and networks.
- Description of the formation, management and evolution of collaborations and networks.
- Collaborations in marketing, development, manufacturing (e.g. NUMMI).
- Special forms of collaborations: mergers & acquisition (e.g. pre- and post-merger activities, joint venture, strategic alliances (e.g. Doz & Hamel, networks, virtual communities)

Learning journey:
In an introductory lecture we will give an overview of the theoretical framework and explain the concept of the lecture (Sept. 18, 2014). In weeks 2-5 you will work on a first assignment on six different aspects of the underlying framework: strategy and activities, structure and process, culture and people orientation, interaction and roles, risk and trust, knowledge and learning. This first assignment will give you the basics to participate in the second part (Oct.30-31.2014, 2014) of this seminar. There you will present the results of the first assignment and get additional theoretical input to perform the 2nd assignment. The second assignment will be to analyze real alliance projects in the partner companies. The final lesson will be used as a best practice exchange together with our industrial partners (Dec.18, 2014).

Lecture notes
- Course script
- Current course material
- Harvard Case Studies
- Reader with current papers

Literature
A list with recommended publications will be distributed in the lecture.

Additional Books:
HBR Collaborating Effectively ISBN 978-1-4221-6264 4
HBR on Mergers and Acquisitions: ISBN 1-57851-555-6

Prerequisites / notice
The number of students participating in the lecture is limited to 30.
Further reading:


The course is intended for students who want to carry out a thesis in industry, in general these are:

(1) MSc-students MTEC or MAVT with master thesis (MA) during the next term and supervised by MTEC, (corresponds to 3rd or 4th semester Master) and
(2) BSc-students MAVT with bachelor thesis (BA) in industry and supervised by MTEC, as well as with full MTEC focus (corresponds to 5th or 6th semester Bachelor) or
(3) MAS MTEC students in 3rd semester for MA during the next term.

Important note: Credits will only be awarded to students according to (1), (2) or (3). Prerequisites for obtaining the credit or "Testat": being present during the whole course (presence list) and prior study of documents provided on the Internet and of the book Züst, R.: Einstieg ins Systems Engineering. 3. Aufl., Verlag Industrielle Organisation, Zürich 2004.

Other students on request (limited places).

Important: the chair coaching your BA/MA defines whether the course is mandatory. Please contact your chair!

Date: Friday 11.09.2015 (13:15-17:00), location: HG E33.1 (ETH main building) and Saturday, 12.09.2015 (09:15-17:00), location: HG E33.1 (ETH main building). Participation at both days required (Friday afternoon and Saturday whole day).

The course is held in English; handouts are available in English.

Besonderes (deutsche Version):

Der Kurs richtet sich an Studierende, welche an einer Professur des D-MTEC eine Arbeit in der Wirtschaft schreiben werden. Im Allgemeinen sind dies:

(1) MSc-Studierende MTEC oder MAVT mit Masterarbeit (MA) im kommenden Semester, die vom MTEC betreut wird, (entspricht 3 oder 4. Semester Master) sowie
(2) BSc-Studierende MAVT mit Bachelorarbeit (BA) in der Wirtschaft, die vom MTEC betreut wird, sowie mit vollem MTEC Fokus (entspricht 5. oder 6. Semester Bachelor) oder
(3) MAS MTEC -Studierende im 3. Semester für MA im kommenden Semester.


Andere Studierende auf Anfrage (beschränkte Anzahl Plätze).

Wichtig: die Professur, welche die jeweilige BA/MA betreut, legt fest, ob der Besuch der Veranstaltung obligatorisch ist. Bitte informieren Sie sich dort!

Elektronische Einschreibung bis zum 08.09.2015 notwendig. Ohne elektronische Einschreibung kann Ihre Teilnahme am Kurs nicht bestätigt werden.

Der Kurs wird als Blockkurs zu Beginn des Semesters gehalten.

Termin: Freitag, den 11.09.2015 (13:15-17:00) im HG E33.1 und Samstag, 12.09.2015 (09:15- ca. 17:00) im HG E33.1 (ETH Hauptgebäude). Anwesenheitspflicht an beiden Tagen (Freitagnachmittag und Samstag ganztag).

Die Veranstaltung wird auf Englisch gehalten; Handouts sind in Englisch verfügbar.

**363-0881-00L** Semester Project Small

- **Abstract**: The semester project (90 hours) is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

- **Objective**: The semester project (90 hours) is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

- **Professors**

**363-0883-00L** Semester Project Large

- **Abstract**: The semester project (180 hours) is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

- **Objective**: The semester project (180 hours) is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

- **Professors**

**363-1021-00L** Monetary Policy

- **Abstract**: The main aim of this course is to analyse the goals of monetary policy and to review the instruments available to central banks in order to pursue these goals. It will focus on the transmission mechanisms of monetary policy and the differences between monetary policy rules and discretionary policy. It will also make connections between theoretical economic concepts and current real world issues.
To deliver the general understanding about why and when regulations are needed; to make students familiar with common regulatory policies and regulatory practices in various industries; and to introduce several classical cases;

By the end of the course, students will have enhanced their understanding of the related microeconomic theories, and will have strengthened their abilities to analyze and to explain regulation issues.

The course gives an introduction to the economic concepts and empirical findings in health economics to enhance students understanding of how health care institutions and markets function.

The course introduces the microeconomic theories and real-life practices of governmental market regulation. We cover several sectors, including energy, telecommunications, environment, and finance. The course is based on the analyses of different kinds of market failure and their corresponding treatments. We conduct both theoretical analyses and case studies.

363-1024-00L Economics of Regulation W 3 credits 2V W. Hu

Abstract
This course introduces the microeconomic theories and real-life practices of governmental market regulation. We cover several sectors, including energy, telecommunications, environment, and finance. The course is based on the analyses of different kinds of market failure and their corresponding treatments. We conduct both theoretical analyses and case studies.

Objective
- To deliver the general understanding about why and when regulations are needed; to make students familiar with common regulatory policies and regulatory practices in various industries; and to introduce several classical cases;
- With this course, we go through a broad range of microeconomic theories that are relevant for regulation, including game theory, industrial organization, environmental economics, and contract theory. Through applying these theories to the regulatory problems, we have an excellent opportunity to see how to use (micro-)economic theories to explain and solve real-life issues.
- By the end of the course, students will have enhanced their understanding of the related microeconomic theories, and will have strengthened their abilities to analyze and to explain regulation issues.

Content
The contents of course include:
- Market failure: the reason for regulation;
- The evolution of price regulation;
- Regulation against the monopoly power: the general idea;
- Regulation practices for the utilities (Electricity and energy, Telecommunications, Environmental regulation, Financial regulation);
- Cost-benefit analysis;
- Extended topics: the asymmetric information problem in regulation.

Literature
The course will be based on chapters of:

Prerequisites / notice
Basic knowledge in international economics and a good background in macroeconomics. The course website can be found at: https://moodle-opp2.let.ethz.ch/course/view.php?id=2457

363-1027-00L Introduction to Health Economics and Policy W 3 credits 2V W. Mimra

Abstract
Health expenditures constitute about 10% of GDP in OECD countries. Extensive government intervention is a typical feature in health markets. Risk factors to health have been changing with growing importance of lifestyle factors such as smoking, obesity and lack of physical activity. This course gives an introduction to the economic concepts and empirical findings in health economics.

Objective
Introduce students without prior economics background to the main concepts of health economics and policy to enhance students understanding of how health care institutions and markets function.

Content
The course gives an introduction to the economic concepts and empirical findings in health economics to enhance students understanding of how health care institutions and markets function. First, the three important decisions made by individuals will be analyzed: What determines the health behaviors, like the intensity of preventive measures like sport, that an individual undertakes? What types and amount of personal health care services does an individual demand? How much health insurance coverage will be purchased? In a second part, the major participants on the supply side of health care markets - physicians, hospitals, nurses and pharmaceutical manufacturers - will be discussed. E.g., how important are financial incentives in the choice of medicine as a career, specialty choice and practice location? What does it mean and imply that a physician is an agent for a patient? How do pharmaceutical firms decide on investments in new products and how can public policy encourage pharmaceutical innovation? The choices made by societies about how health care services are financed and about the types of organizations that supply health care will be addressed in a third part. One important choice is whether a country will rely on public financing of personal health care services or encourage private health insurance markets. How could and should a public health insurance system be designed? What health care services should be included or excluded from a public system? Another important choice is whether a society relies on government provision of health care services, private provision by not-for-profit or for-profit organizations or some combination. The advantages and disadvantages of the alternatives will be discussed to provide a framework for analyzing specific types of health care systems.

Literature
Lodge, M., M. Cave and R. Baldwin (eds.), The Oxford Handbook of Regulation, Oxford University Press, 2010. (accessible online via the school network)

363-1036-00L Empirical Innovation Economics W 3 credits 2G M. Wörter

Abstract
The course focuses on important factors that drive the innovation performance of firms, like innovation capabilities, science-industry relationships, environmental policy and it shows how innovation activities relate to firm performance and to the technological dynamic of industries. Hence, the course provides an understanding of the relationship between technical change and industrial dynamics.

Objective
The course provides students with the basic skills to understand and assess empirically the technological activities of firms and the technological dynamics of industries.

Content
The course consists of two parts. Part I provides an introduction into important topics in the field of the economics of innovation. Part II consists of empirical exercises based on the KOF Innovation Data. In part I we will learn about ...a) market conditions that encourage firms to invest in R&D (Research and Development) and develop new products. ...b) the role of universities for the technological activities of a firm (technology transfer), ...c) how technologies diffuse among firms. ...d) how the R&D activities of firms are affected by economic crises and how firms finance their R&D activities. ...e) how we can measure the returns to R&D activities. ...f) how (environmental) policies affect the technological activities of a firm. In part II we will use the KOF Innovation Survey Data in order to assess empirically the technological activities of firms referring to the topics introduced in part I.

Lecture notes
Will be provided in the course

Literature
Specific academic papers and cases will be studied during the lectures.

Prerequisites / notice
Students are expected to have taken at least one basic microeconomics course. Knowledge about game theory, industrial organization and public economics will be useful. Knowledge about contract theory is a plus.

363-1027-00L Introduction to Health Economics and Policy W 3 credits 2V W. Mimra

Abstract
Health expenditures constitute about 10% of GDP in OECD countries. Extensive government intervention is a typical feature in health markets. Risk factors to health have been changing with growing importance of lifestyle factors such as smoking, obesity and lack of physical activity. This course gives an introduction to the economic concepts and empirical findings in health economics.

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Lecture notes
Will be provided in the course

Literature
Specific academic papers and cases will be studied during the lectures.

Prerequisites / notice
Students are expected to have taken at least one basic microeconomics course. Knowledge about game theory, industrial organization and public economics will be useful. Knowledge about contract theory is a plus.

363-1042-00L Strategic Career Development Z 0 credits 1V P. Cettier

Abstract
The offer Strategic Career Development has the goal to support students in the development and alignment of their personal & professional goals. Orientation, Goal setting, action plan development, motivation letter, CV, interview training We will include high level external guest speakers
Objective We will discuss and develop answers to the following questions:

What do I want to achieve in my life?
Why is it to important to define goals?
What decision criteria can I use as a guide?
How do potential career paths look like? What are the possibilities?
How does the life cycle of a career look like? What are the alternatives?
How do I increase my chances of success/reaching my goals?
How did others do it? What kind of advice can experienced captains of industry give?
Why is a periodic check of my goals and my progress necessary?

Content
INTRODUCTION
Awareness building / Overview on the career life cycle / Examples from praxis / Exchange of experiences / Approach for goalsetting / Introduction to the success secrets of a career

ORIENTATION AND GOAL SETTING
Class discussion of the success secrets of a career / Orientation on career options / Discussion of possible decision criteria / Initial formulation of concrete goals

External guest speaker: Inspiring Start-up Entrepreneur

CAREER DEVELOPMENT PLANS
Exchange w/representatives of industries / Personal Values & Norms vs Corporate Identity / Work-Life Balance Gender / Diversity / Summary of discussions / Best practice / Modification/Sharpening of goals

External guest speaker: Representatives from Hilti AG Switzerland

DETAILING OF INDIVIDUAL CAREER PLANS
Development of detailed individual career plans / Next steps / action plan / Tips & Tricks for careers in organizations and entrepreneurship

REVIEW & APPLICATION COUNSELING
Review/check of goals and career plans / Motivation letter / CV / Preparation for interviews

INTERVIEW TRAINING
In today’s world of everything is possible it becomes an every increasing challenge to find orientation, to define a goal for which it is worth to work for and energy. But this is exactly what is so important in today’s work environment. Only with a definite goal one can decide if the taken path is right, one can develop enough motivation to go beyond the comfort zone. With a definite goal, one increases the chances of success of one’s education and career. The earlier one has defined what he/she wants to achieve, the bigger the effect.

Prerequisites / notice
Motivation. Strategic long-term view.

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Literature</th>
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<tbody>
<tr>
<td>Course slides will be made available to students prior to each class.</td>
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</table>

363-1047-00L Economics of Urban Transportation W 3 credits 2G A. Russo

Abstract The first part of the course will present some basic principles of transportation economics, applied to the main issues in urban transport policy (e.g. road pricing, public transport tariffs, investment in infrastructure etc.). The second part of the course will consider some case studies where we will apply the tools acquired in the first part to actual policy issues.

Objective The main objective of this course is to provide students with some basic tools to analyze transport policy decisions from an economic perspective. Can economics help us reduce road congestion problems? Should drivers be asked to pay for using urban roads? Should public transport tariffs depend on how roads are priced? How should the investment in transport infrastructure be financed? These are some of the questions that students should be able to tackle after completing the course.

Content COURSE OUTLINE (preliminary):

1. Introduction
2. Travel demand:
   a. travel cost and value of time
   b. mode choice
3. Road congestion and first-best pricing
   a. Static congestion model
   b. Dynamic congestion models
   c. Examples: London Congestion Charge, Stockholm Congestion Charge
4. Second-best pricing
   a. Pricing roads with unpriced alternatives. Examples: tolled and toll-free highways
   b. Public transport: pricing with road congestion and with (or without) road tolls
5. Investment in infrastructure: public transport and roads
   a. Roads: Investment with and without pricing
   b. induced demand
   c. Economies of scale/density in public transport
6. Topics:
   a. Political economy of road pricing: why do we see road pricing in so few cities (London, Stockholm...) and not in many other cities (NYC, Manchester, Paris...)?
   b. What are the alternatives to road pricing to reduce congestion? Parking tariffs, traffic regulation (speed bumps, low emission zones), road space reduction. Examples: Zurich, San Francisco (SFPark), Paris.
   c. Transport and land use: value of housing and transport services. Road congestion, transport subsidies and urban sprawl.

Lecture notes SYLLABUS (preliminary):
course slides will be made available to students.

Additional material:
Part 1 to 5: textbook: Small and Verhoef (The economics of urban transportation, 2007).
Part 6: Topics to be covered on research papers/case studies.

363-1048-00L Sustainable Supply Chain Management W 3 credits 2G C. Busse

Abstract The course focuses on the establishment of sustainability in firm's supply chains (that is, in their internal operations, in their logistics processes, and in their upstream supply chains). We will consider how supply chains can become more sustainable, as well as the extent to which firms are interested in such a development.
This course aims to equip students with an in-depth knowledge of the sustainability-related challenges and problems within supply chain management, and suggests some tools for managing these challenges. Equally importantly, the course seeks to capacitate students for understanding and analyzing the tradeoffs and conflicts of target within sustainable supply chain management.

The content of the course is closely linked to the latest research in the field, meaning that the absence of simple solutions will be the rule, rather than the exception. Moreover, the course will be highly interactive, and there will be intensive coursework during the course.

Objective

- This course assumes no prerequisites. However, to profit most from the course, it would be desirable if students attended the MTEC courses on Entrepreneurial Leadership (MTEC MSc course no. 363-0448-00L), on Strategic Supply Chain Management (MTEC MSc course no. 363-0453-00L), on Purchasing and Supply Management (MTEC MSc course no. 363-0452-00L) and on Corporate Sustainability (MTEC MSc course no. 363-0387-00L) beforehand. Moreover, the course builds on and details lectures on Sustainable Supply Chain Management within the course LOS II: Manufacturing Strategies - From Supply Chain Design to Factory Planning II (MTEC MSc course no. 363-0448-00L).

Content

The preliminary course outline is as follows:

Module 1: Motivation for SusSCM
- Introductory case study
- Basic terminology
- Sustainability issues
- Dilemmas for firms
- Motivation for firms to engage in SusSCM
- SusSCM and LCA
- Specificity of SusSCM

Module 2: Sustainable operations management
- Lean and green
- CO2 emissions: measurement and management
- Extended producer responsibility
- Recycling

Module 3: Sustainable logistics
- Closed-loop supply chain management and reverse logistics
- Sustainable transportation: foundations related to energy and CO2
- Sustainable transportation: improvement measures related to energy and CO2
- Sustainable transportation: other sustainability-related issues
- Sustainable warehousing: basics and sustainability-related benefits
- Sustainable warehousing: sustainability-related challenges

Module 4: Sustainable purchasing and supply management
- Introduction to sustainable purchasing and supply management
- Sustainable supply management
- Information processing prerequisites to sustainable supply management
- GRI supply chain issue reporting
- Sustainability-oriented supply chain risk management

There are no formal prerequisites. However, to profit most from the course, it would be desirable if students attended the MTEC courses on Entrepreneurial Leadership (MTEC MSc course no. 363-0448-00L), on Strategic Supply Chain Management (MTEC MSc course no. 363-0453-00L), on Purchasing and Supply Management (MTEC MSc course no. 363-0452-00L) and on Corporate Sustainability (MTEC MSc course no. 363-0387-00L) beforehand. Moreover, the course builds on and details lectures on Sustainable Supply Chain Management within the course LOS II: Manufacturing Strategies - From Supply Chain Design to Factory Planning II (MTEC MSc course no. 363-0448-00L).
Students have to work on three to four real Bühler cases and present the solutions in class.

Cases in Technology Marketing
F. von Wangenheim
In this endeavour you are coached and supported by
3S

In your team, you will work on a specific assignment that flows from the current strategic agenda of the board. While gaining substantial insights into the structure, dynamics and challenges of the industry, you immerse into the business model and strategic landscape of the corporate partner. You visit their headquarter, conduct interviews with members of the management team as well as internal and external experts before you discuss your ideas with top executives. To secure impact, it is key that you formulate your recommendations from a deep understanding of the authentic leadership culture of the corporate partner.

Prerequisites / notice
Please apply for this course via the official website (www.mtec.ethz.ch) - to be opened by end of May 2016. Apply no later than August 22. The number of participants is limited to 18.

ECTS: 4
Participants receive a certificate.

363-1051-00L Cases in Technology Marketing

W 3 credits 1G F. von Wangenheim, C. Grieder

Number of participants limited to 20.

Students have to apply for this course by sending a CV and an one-page motivation letter to mgrohmann@ethz.ch. Additionally please enroll via myStudies. Places will be assigned on the basis of your motivation letter.

Abstract
The aim of this module is to introduce students to some key concepts in technology marketing and to familiarize them subsequently with the challenges that (marketing) managers face in technology intensive markets by using real life cases. Students will have to "solve" current and past managerial problems and will be enabled to compare their solutions with what has actually been done.

Objective
This module should enable students to deal with the uncertainty related to challenges in technology marketing by introducing them to some key concepts and letting them apply those concepts to real life cases. The competences acquired in this module are meant to go beyond the mere understanding of the study material by improving students' problem solving capabilities, analytical skills and capacity for teamwork. Furthermore, students will be exposed to decision-making styles and procedures in companies.

Content
Students have to work on three to four real Bühler cases and present the solutions in class.

Solutions/ presentations will be part of the grades.

Prerequisites / notice
Students have to apply for this course by sending a CV and a one-page motivation letter until 09.09.2015 to mgrohmann@ethz.ch.

363-1055-00L Marketing Practice

W 3 credits 3S F. von Wangenheim

Please send your application documents (Cover Letter, CV, Transcript of Records, Reports) by 30.09.2016 to: mgrohmann@ethz.ch

Once your application has been confirmed, a registration in myStudies is possible.

Abstract
The course enables students to apply their knowledge from marketing and other disciplines to real life cases under the supervision of internationally operating partner companies.

Objective
First, students have to assess and analyse real life problems in order to generate creative solutions.

Secondly, students have to demonstrate that they are both - able to apply their knowledge from marketing theory to practice, as well as to communicate their ideas to other students and leading marketing executives.

Content
The Circle of Excellence is a one-year talent program for outstanding students together with the universities of Münster, Cologne and Berlin. It aims at preparing the participants for interesting management tasks within various workshops in collaboration with our internationally operating partner companies, e.g. PanGas, L'Oréal, Henkel, McKinsey, EDEKA,....

Please find more information on:
http://www.circle-of-excellence-marketing.de

Prerequisites / notice
Your profile:
- Strong interest in Marketing topics
- Very good academic performance
- Interesting and convincing personality
- High commitment and flexibility

Students have to organize the remaining phase of their studies in a way that they are able to participate in the workshops.

363-1065-00L Design Thinking: Human-Centred Solutions to Real World Challenges

W 5 credits 5G A. Cabello Llamas, F. Rittiner, S. Brusoni, C. Hölscher, M. Meboldt

Due to didactic reasons, the number of participants is limited to 30.

All interested students are invited to apply for this course by sending a one-page motivation letter until 14.9.16 to Florian Rittiner (rittiner@ethz.ch).

Additionally please enroll via mystudies. Places will be assigned after the first lecture on the basis of your motivation letter and commitment for the class.

Abstract
The goal of this course is to engage students in a multidisciplinary collaboration to tackle real world problems. Following a design thinking approach, students will work in teams to solve a set of design challenges that are organized as a one-week, a three-week, and a final six-week project in collaboration with an external project partner.

Information and application: www.sparklabs.ch/ethz
Objective
During the course, students will learn about different design thinking methods and tools. This will enable them to:
- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

Content
The purpose of this course is to equip the students with methods and tools to tackle a broad range of problems. Following a Design Thinking approach, the students will learn how to observe and interact with key stakeholders in order to develop an in-depth understanding of what is truly important and emotionally meaningful to the people at the center of a problem. Based on these insights, the students ideate on possible solutions and immediately validated them through quick iterations of prototyping and testing using different tools and materials.

Design Thinking is a deeply human process that taps into the creative abilities we all have, but that get often overlooked by more conventional problem solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as functional, and to express ourselves through means beyond words or symbols. Design Thinking provides an integrated way by incorporating tools, processes and techniques from design, engineering, the humanities and social sciences to identify, define and address diverse challenges. This integration leads to a highly productive collaboration between different disciplines.

For more information and the application visit: http://sparklabs.ch/ethz

Prerequisites / notice
Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

376-1177-00L Human Factors I

Abstract
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective
The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry, Digital Human Models
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature
- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students
- Further textbooks are introduced in the lecture
- Brouchures, checklists, key articles etc. are uploaded in ILIAS

363-1050-00L Conference of Disarmament: Simulation of Negotiations

Abstract
The Global Studies Institute (University of Geneva) is organizing a simulation seminar on nuclear disarmament in collaboration with the Chair of Negotiation and Conflict Management (ETH), experts from the United Nations Institute for Disarmament Research and the Geneva Center for Security Policy.

Objective
The simulation is conducted in collaboration with experts and students during a two days seminar at the University of Geneva.

Students will have the possibility to participate in simulated diplomatic negotiations and to analyse and assess the negotiation logic behind the situations. They should gain insight in the basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general.
The simulation project is intended for Master's or Doctoral students of the Global Studies Institute (GSI) of the University of Geneva, of the ETH and for interested students of the Geneva Centre for Security Policy (GCSP). The simulation will be in French and English and is conducted by Prof. Calmy-Rey, former President of Switzerland.

In the lectures, students will be provided with basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general. Students will take the role of negotiators in the simulation (including the heads of the delegations), of keeper of the minutes or of observers and analysts. Students will co-develop their mandates for the negotiation and be assisted by experts that are specialized in international negotiations as well as in the topic of disarmament. The negotiation tables will be chaired by former diplomats. Representatives of diplomatic missions in Geneva will play the role of the "Capitals" to which the heads of delegations will have to give account of the ongoing negotiations.

More details on the program, timetable, reading lists and performance assessment will be published here: https://chamilo.unige.ch/home/courses/M165/?id_session=0

The simulation will take place on the 26 and 27 November 2015 at the University of Geneva.

Languages: English and French

Dates/Time/Location (GE = University of Geneva)

22 Sept. | ETH HG D 22 | 10:15-12:00 | Introduction
29 Sept. | GE Uni Mail Salle 1170 | 10:15-12:00 | Introduction to Negotiation Techniques (Dr. Vitalijs Butenko and Dr. Sibylle Zürcher, ETH)
6 Oct. | ETH HG D 16.2 | 10:15-12:00 | Distribution of the roles, composition of the negotiation tables, preparation of mandates for the HA (humanitarian approach)
13 Oct. | ETH HG D 22 | 10:15-12:00 | Preparation of the mandates for the FMCT (Fissile Material Cut-off Treaty)
20 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | No session; Students deepen and summarize their mandates on one page (A4)
27 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates I (FMCT)
10 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates II (HA)
17 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Preparation Meeting
26 & 27 Nov. | GE Salles 407 et 408 | 10:00-18:00 | Simulation at Uni Dufour
1 Dec. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the results

Note:
The participation in the simulation on 26. and 27. November in Geneva is necessary.
The two hours lectures on the 22. September, 6. and 13. October have to be attended in Zürich via conference call (ETH HG D 16.2). The other lectures during the semester can be attended via Skype.
To get the 3 ECTS, students have to participate at the 2 days simulation In Geneva, attend the 3 mandatory lecture parts via conference call an Zürich and write a report of 5 pages at the end of the course.

(Technical note for registration: At this stage all registered students are on the waiting list)

▶ Supplementary Courses

The students have to deepen their knowledge in the area(s) of engineering/natural sciences in consultation with the responsible professor (tutor). Core courses and electives of D-MTEC can not be used as supplementary courses.

Course Catalogue of ETH Zurich

▶ Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0879-00L</td>
<td>Practical Training</td>
<td>O</td>
<td>6 credits</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

Abstract
The practical experience gained by the student completes the studies at the Swiss Federal Institute of Technology and prepares her/him for future activities in industry.

Objective
The practical experience gained by the student completes the studies at the Swiss Federal Institute of Technology and prepares her/him for future activities in industry.

▶ Master’s Thesis

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>363-0600-00L</td>
<td>Master’s Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>57D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
Only students who fulfill the following criteria are allowed to begin with their master thesis:
- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme;
- c. internship fulfilled;
- d. academic writing course has been completed (students from Spring Semester 2015 onwards).

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and normally deals with a subject contained in the major fields. The research will be performed normally within a private company or at the ETH Zurich.

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-1063-00L</td>
<td>Academic Writing Course</td>
<td>O</td>
<td>0 credits</td>
<td>1G</td>
<td>R. Mihalka, S. Milligan</td>
</tr>
</tbody>
</table>

Abstract
This course for MTEC master's students will focus on developing and refining students’ English writing skills and their understanding of the requirements and conventions of academic writing.
Objective

The course develops a range of practical and transferrable writing skills. Its first aim is to improve the academic writing skills necessary for the successful completion of an MSc thesis. The course provides theoretical input, practical writing exercises, and detailed individual feedback. It is organized into an initial group lecture and four subsequent workshops in smaller tutorial groups.

The group lecture raises awareness about academic conduct, especially with regard to plagiarism. Afterwards, students take placement tests so that the areas where they need improvement can be identified. The following workshops concentrate on these highlighted areas, and feedback on placement tests is integrated into the input and practice during these sessions.

Students can use the skills developed on the course to improve the overall quality of their MSc theses and to produce their thesis more rapidly and efficiently. These skills can also be used beyond the MSc, whether students go on to complete a PhD or to produce reports and other documents in industry.

Content

Group lecture:
- an introduction to writing an MSc thesis in D-MTEC
- selecting topic and supervisor
- academic expectations
- avoiding plagiarism

Workshop 1:
- the writing process
- reading, note taking and planning
- overview of the thesis structure
- building academic vocabulary

Workshop 2:
- writing methods sections
- embedding figures and tables
- structuring sentences and paragraphs
- noun phrases and articles

Workshop 3:
- introductions; results and discussion sections
- analysis v description
- writing critically
- relative clauses

Workshop 4:
- abstracts and conclusions
- editing your own text
- punctuation, spelling, and grammar

Lecture notes

Notes will be available after registration.

Management, Technology and Economics Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

| V  | lecture                     | P  | practical/laboratory course         |
| G  | lecture with exercise       | A  | independent project                 |
| U  | exercise                    | D  | diploma thesis                      |
| S  | seminar                    | R  | revision course / private study     |
| K  | colloquium                  |    |                                      |

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
First Year Examinations: Compulsory Courses

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
401-0261-00L | Analysis I | O | 8 credits | 5V+3U | A. Steiger

**Abstract**
Differential and integral calculus for functions of one and several variables; vector analysis; ordinary differential equations of first and of higher order, systems of ordinary differential equations; power series. The mathematical methods are applied in a large number of examples from mechanics, physics and other areas which are basic to engineering.

**Objective**
Introduction to the mathematical foundations of engineering sciences, as far as concerning differential and integral calculus.

**Literature**
U. Stammbach: Analysis I/II

**Prerequisites / notice**
Die Übungsaufgaben (inkl. Multiple Choice) sind ein wichtiger Bestandteil der Lehrveranstaltung. Es wird erwartet, dass Sie mindestens 75% der wöchentlichen Serien bearbeiten und zur Korrektur einreichen.

401-0171-00L | Linear Algebra I | O | 3 credits | 2V+1U | N. Hungerbühler

**Abstract**
Linear algebra is an indispensable tool of engineering mathematics. The course offers an introduction into the theory with many applications. The new notions are practised in the accompanying exercise classes. The course will be continued as Linear algebra II.

**Objective**
Upon completion of this course, students will be able to recognize linear structures, and to solve corresponding problems in theory and in practice.

**Content**
Systems of linear equations, Gaussian elimination, solution space, matrices, LR decomposition, Determinants, structure of linear spaces, normed vector spaces, inner products, method of least squares, QR decomposition, introduction to MATLAB, applications

**Literature**

**Prerequisites / notice**
Active participation in the exercises is part of this course. It is expected, that students submit 3/4 of all exercises for control.

151-0501-00L | Mechanics 1: Kinematics and Statics | O | 5 credits | 3V+2U | E. Mazza

**Abstract**
Basics: Position of a material point, velocity, kinematics of rigid bodies, forces, reaction principle, mechanical power
Statics: Groups of forces, moments, equilibrium of rigid bodies, reactions at supports, parallel forces, center of gravity, statics of systems, principle of virtual power, trusses, frames, forces in beams and cables, friction

**Objective**
The understanding of the fundamentals of statics for engineers and their application in simple settings.

**Content**
Grundlagen: Lage eines materiellen Punktes; Geschwindigkeit; Kinematik starrer Körper, Translation, Rotation, Kreiselung, ebene Bewegung; Kräfte, Reaktionsprinzip, innere und äussere Kräfte, verteilte Flächen- und Raumkräfte; Leistung
Statik: Äquivalenz und Reduktion von Kräftegruppen; Ruhe und Gleichgewicht, Hauptsatz der Statik; Lagerbindungen und Lagerkräfte, Lager bei Balkenträgern und Wellen, Vorgehen zur Ermittlung der Lagerkräfte, Parallelen Kräfte und Schwierpunkt; Statik der Systeme, Behandlung mit Hauptsatz, mit Prinzip der virtuellen Leistungen, statisch unbestimmte Systeme; Statisch bestimmte Fachwerke, ideale Fachwerke, Pendelstützen, Knotengleichgewicht, räumliche Fachwerke; Reibung, Haftreibung, Gleitreibung, Gelenk und Lagereibung, Rollreibung; Seilstatik; Beanspruchung in Stabträgern, Querkraft, Normalkraft, Biege- und Torsionsmoment

**Prerequisites / notice**
Active participation in the exercises is part of this course. It is expected, that students submit 3/4 of all exercises for control.

151-0711-00L | Engineering Materials and Production I | O | 4 credits | 4G | K. Wegener

**Abstract**
The lecture covers the structure and the properties of metallic materials. In the focus are the branches: microscopic structure; thermally activated processes; solidification; elastic, plastic deformation, creep. Generally the lecture also refers to manufacturing, to the processing, and application of the concerning materials.

**Objective**
Understanding the basics of metallic materials for engineers who are confronted with material decisions in design and production.

**Content**
The lecture covers the structure and the properties of metallic materials. In the focus are the branches: microscopic structure as ideal and real structure, alloying, thermally activated processes e.g. diffusion, recovery, recrystallisation, solidification, elastic and plastic deformation and creep. Generally the lecture also refers to manufacturing, to the processing, and application of the concerning materials.

**Lecture notes**
yes

151-0301-00L | Machine Elements | O | 2 credits | 1V+1U | M. Meboldt, Q. Lohmeyer

**Abstract**
Introduction to machine elements and mechanical systems as basics of product development. Case studies of their application in products and systems.

**Objective**
The students get an overview of the main mechanical components (machine elements) which are used in mechanical engineering. Selected examples will demonstrate how these can be assembled into functional parts and complete systems such as machinery, tools or actuators. At the same time, also the problem of production (production-oriented design) is discussed.

**Content**
- Innovation Process: A Quick Overview
- Stages of the planning and design process
- Requirements for a design and technical implementation
- Choice of materials - Basic principles of a material-specific design
- Manufacturing process - fundamentals of a production-oriented design
- Connections, fuses, seals
- Machine-standard elements
- Storage & guides
- Transmission and its components
- Drives

The idea of machine elements is complemented by case studies and illustrated.
The lecture slides will be published beforehand on the website of the pd|z.

For Bachelor studies in Mechanical and Process Engineering, the lecture "Maschinenelemente" (HS) is examined together with "Innovationsprozess" (FS) in the exam "Basisprüfung Maschinenelemente and Innovationsprozess".

**Chemistry**

**Abstract**

This is a general chemistry course aimed at first year undergraduate students in the Department of Mechanical and Process Engineering (D-MAVT).

**Objective**

The aims of the course are as follows:
1. To provide a thorough understanding of the basic principles of chemistry and its application.
2. To develop an understanding of the atomic and molecular nature of matter and of the chemical reactions that describe their transformations.
3. To emphasize areas considered most relevant in an engineering context.

**Content**

Electronic structure of atoms, chemical bonding, molecular shape and bonding theory, gases, thermodynamics, chemical thermodynamics, chemical kinetics, equilibria, solutions and intermolecular forces, redox and electrochemistry.

**Literature**

The course is based on "Chemistry the Central Science" by Brown, LeMay, Bursten, Murphy and Woodward. Pearson, 12th Edition (international edition).

### Additional First Year Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>151-0321-00L</td>
<td>Technical Drawing and CAD</td>
<td>O</td>
<td>4 credits</td>
<td>4G</td>
<td>K. Shea</td>
</tr>
</tbody>
</table>

**Abstract**


**Objective**

The lecture and exercises teach the fundamentals of technical drawing and CAD. After taking the course students will be able to create accurate technical drawings of parts and assemblies as well as read them. Students will also be able to create models of parts and assemblies in a 3D, feature-based CAD system. They will understand the links with simulation, product data management (PDM) and additive manufacturing.

**Content**

Introduction to Engineering Design

Technical Drawing:
- projections and views
- cuts
- notations
- primitives
- ISO norm elements
- dimensioning
- tolerances
- assemblies
- documentation

CAD:
- CAD basics
- CAD modeling methods
- sketch modeling
- modeling operations
- feature-based modeling
- assemblies
- creating 2D drawings from 3D parts
- links to simulation, e.g. kinematics
- links to model variants and Product Data Management (PDM)
- links to additive manufacturing (3D printing)

**Lecture notes**

Lecture slides and exercise handouts are available on the course Moodle website: https://moodle-app2.let.ethz.ch/course/index.php?categoryid=56

**Literature**

In addition to the lecture material the following books are recommended (only in German):

TZ
Technisches Zeichnen: selbstständig lernen und effektiv üben
Susanna Labisch und Christian Weber
2008 Vieweg
eBook (accessible from the ETH domain): http://link.springer.com/book/10.1007/978-3-8348-9451-9/page/1

VSM Normen-Auszugs 2010
(kann in den Übungen bestellt und gekauft werden)

CAD
Marcel Schmid
CAD mit NX: NX 8
J.Schlembach Fachverlag
ISBN: 978-3-935340-72-4

**Prerequisites / notice**

This course is given as a lecture (1h/week) and an exercise (3h/week). Students are split into working groups for the exercises with a maximum of 20 students per group.

**Semester Fee**

A fee is charged for printed copies of the course handouts.

### First Year Optional Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0501-02L</td>
<td>Mechanics 1: Kinematics and Statics (Colloquium)</td>
<td>Z</td>
<td>0 credits</td>
<td>1K</td>
<td>E. Mazza</td>
</tr>
</tbody>
</table>

**Abstract**

Basics: Position of a material point, velocity, kinematics of rigid bodies, forces, reaction principle, mechanical power
Statics: Groups of forces, moments, equilibrium of rigid bodies, reactions at supports, parallel forces, center of gravity, statics of systems, principle of virtual power, trusses, frames, forces in beams and cables, friction

**Prerequisites / notice**

This course is given as a lecture (1h/week) and an exercise (3h/week). Students are split into working groups for the exercises with a maximum of 20 students per group.
Objective
The understanding of the fundamentals of Statics for engineers and their application in simple settings.

Content
Basics: Position of a material point; velocity; kinematics of rigid bodies; translation, rotation, planar motion; forces, action-reaction principle, internal and external forces, distributed forces; mechanical power.
Statics: equivalence and reduction of groups of forces; rest and equilibrium; basic theorem of statics; kinematic and static boundary conditions, applications to supports and clamps of rods and beams; procedures for determination of forces at supports and clamps; parallel forces and centre of gravity; statics of systems, solution using basic theorem and using the principle of virtual power, statically indeterminate systems; statically determinate truss structures, ideal truss structures, nodal point equilibrium, methods for truss force determination; friction, static friction, sliding friction, friction at joints and supports, rolling resistance; forces in cables; beam loading, force and moment vector.

Lecture notes
Übungsblätter

Literature
Sayir, M.B., Dual J., Kaufmann S., Ingenieurmechanik 1: Grundlagen und Statik, Teubner

3. Semester

Compulsory Courses

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0363-10L</td>
<td>Analysis III</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>M. Soner</td>
</tr>
</tbody>
</table>

Abstract
Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

Objective
Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.

The first lecture is on Thursday, September 29 13-15 in HG F 7 and video transmitted into HG F 5.

The exercises Sheet are here:

The coordinator is Claudio Sibilia (see https://www.math.ethz.ch/the-department/people.html?u=sibiliac)

The first exercise session is on Thursday, September 22 or resp. Friday, September 23. If you would like feedback on your work, please give it to your course assistant or leave it in the box of your course assistant in HG F 27. The due Date is one week later the assignment.

Office hour (Praesenz): Thursday 16-17, NO E 39.

Content
Laplace Transforms:
- Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
- Transforms of Derivatives and Integrals, ODEs
- Unit Step Function, t-Shifting
- Short Impulses, Dirac's Delta Function, Partial Fractions
- Convolution, Integral Equations
- Differentiation and Integration of Transforms

Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:
- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates; Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

Download the syllabus: https://polybox.ethz.ch/index.php/s/6BUKy8vWYqYnAa

Lecture notes
Alessandra lozzi's Lecture notes: https://polybox.ethz.ch/index.php/s/i/RcsFm70tWChEq7H

Errata: https://polybox.ethz.ch/index.php/s/VKtR66gyQRTlwE0w

Literature

For reference/complement of the Analysis I/II courses:
Christian Blatter: Ingenieur-Analysis (Download PDF)

<table>
<thead>
<tr>
<th>Number</th>
<th>Dynamics</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0503-00L</td>
<td>O</td>
<td>6</td>
<td>4V+2U</td>
<td>G. Haller, P. Tiso</td>
<td></td>
</tr>
</tbody>
</table>

Abstract
Kinematics, dynamics and oscillations: Motion of a single particle - Motion of systems of particles - 2D and 3D motion of rigid bodies - Vibrations
Objective

This course provides Bachelor students of mechanical engineering with fundamental knowledge of kinematics and dynamics of mechanical systems. By studying motion of a single particle, systems of particles and rigid bodies, we introduce essential concepts such as work and energy, equations of motion, and forces and torques. Further topics include stability of equilibria and vibrations. Examples presented in the lectures and weekly exercise lessons help students learn basic techniques that are necessary for advanced courses and work on engineering applications.

Content


Lecture notes

Hand-written slides will be downloadable after each lecture.

Literature

Typed course notes from the previous year

Prerequisites / notice

Please log in to moodle (https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php), search for “Dynamics”, and join the course there. All exercises sheets, lecture materials etc. will be uploaded there.

151-0303-00L

Dimensioning I

Abstract

Introduction to dimensioning (strength calculation) for static and dynamic loaded components and machine parts. Critical strength and fracture criteria. Analytical methods for the calculation of stresses and strains. Consideration of stress concentrations by notch effects. Strength proof for different machine elements:

Objective

The lecture uses basic strength theory from Mechanics II to size and design typical machine elements as beam structures, axes and shafts, pressure vessels, weldings and screws. The students learn to define both geometry and material of frequently used machine elements.

Content

- Theoretical basics of engineering design
- Description of ductil and brittle material behavior
- Design of machine elements at static loading conditions
- Notch effects
- Axes and shafts
- Fatigue design
- Surface pressure
- Rotationally symmetric bodies, pressure vessels and cylindrical interference
- Dimensioning of permanent and separable joints

Lecture notes

The lecture bases on the books specified under "LITERATUR". The books 1) to 5) can be downloaded as pdf's. Additional documentation and handouts are available as PDFs on our website.

Literature

4) M. Meier und P. Ermanni, Dimensionieren 1, Zürich, 2012.

151-0051-00L

Thermodynamics I

Abstract

Introduction to the fundamentals of technical thermodynamics.

Objective

Introduction to the fundamentals of technical thermodynamics.

Content

1. Konzepte und Definitionen
2. Der erste Hauptsatz, der Begriff der Energie und Anwendungen für geschlossene Systeme
3. Eigenschaften reiner kompressibler Substanzen, quasi-statische Zustandsänderungen
4. Elemente der kinetischen Gastheorie
5. Der erste Hauptsatz in offenen Systemen - Energieanalyse in einem Kontrollvolumen
6. Der zweite Hauptsatz - Der Begriff der Entropie
7. Nutzbarkeit der Energie - Exergie
8. Thermodynamische Beziehungen für einfache, kompressible Substanzen

Lecture notes

available

Literature


151-0591-00L

Control Systems I

Abstract

Analysis and synthesis of linear systems with one input and one output signal (SISO); transition matrix; stability; controllability; observability; Laplace transform; transfer functions; transient and steady state responses. PID control; dynamic compensators; Nyquist theorem.

Objective

Introduction to main ideas of linear systems analysis and synthesis. Transient and steady-state behavior, system engineering (input/output, static/dynamic behavior, feedforward and feedback loops, etc.), introduction of most important tools (solution of linear ODE, Laplace transformation, Nyquist theorem, etc.). Elementary controller synthesis (leads, poles).

Content


Lecture notes


Prerequisites / notice

Basic knowledge of (complex) analysis and linear algebra

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**Examination Block 2**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0033-10L</td>
<td>Physics I</td>
<td>O</td>
<td>6</td>
<td>4V+2U</td>
<td>W. Wegscheider</td>
</tr>
</tbody>
</table>

This is a two-semester course introducing students into the foundations of Modern Physics. Topics include electricity and magnetism, light, waves, quantum physics, solid state physics, and semiconductors. Selected topics with important applications in industry will also be considered.
Objective
The lecture is intended to promote critical, scientific thinking. Key concepts of Physics will be acquired, with a focus on technically relevant applications. At the end of the two semesters, students will have a good overview over the topics of classical and modern Physics.

Content
Electric and magnetic fields, current, magnetism, Maxwell's equations, concept of light, classical optics, waves.

Lecture notes
Notes from lectures will be available (in German).

Literature
Friedhelm Kuypers
Physik fuer Ingeniure und Naturwissenschaftler

Paul A. Tipler, Gene Mosca, Michael Basler and Renate Dohmen
Physik für Wissenschaftler und Ingenieure
Spektrum Akademischer Verlag, 2009, 1636 Seiten, ca. 80 Euro.

Engineering Tools II
The participation at the Engineering Tools course is mandatory. If you miss any classes, no credit points will be awarded. For exemptions you have to contact the lecturer of the course.

Number | Title | Type | ECTS | Hours | Lecturers |
--- | --- | --- | --- | --- | --- |
151-0021-00L | Engineering Tool II: Introduction to MATLAB | O | 0.4 credits | 1K | B. Berisha, P. Hora |
Abstract
Introduction to MATLAB; vectors and matrices; graphics in MATLAB; calculus, differential equations; programming with MATLAB; data analysis and statistics; interpolation and polynomials. Exercises with solutions: using MATLAB commands, technical applications.

Objective
Introduction to numerical calculations with MATLAB.

Content
Introduction to MATLAB; vectors and matrices; graphics in MATLAB; calculus, differential equations; programming with MATLAB; data analysis and statistics; interpolation and polynomials. Exercises with solutions: using MATLAB commands, technical applications.

Prerequisites / notice
Der Kurs findet in einem Hörsaal statt und es stehen keine Rechner zur Verfügung. Es wird empfohlen, dass pro zwei Studierenden mindestens ein Laptop mit installiertem Matlab mitgebracht wird.

Installation Matlab:
- es funktionieren alle Versionen
- netzunabhängige Node-Lizenz (z.B. zum Download auf IDES)
- folgende Toolboxes/Features müssen installiert sein: Simulink (wird für RT1 benutzt), Curve Fitting Toolbox, Optimization Toolbox, Symbolic Toolbox, Global Optimization Toolbox

5. Semester

Compulsory Courses Examination Block 3

Number | Title | Type | ECTS | Hours | Lecturers |
--- | --- | --- | --- | --- | --- |
151-0261-00L | Thermodynamics III | O | 3 credits | 2V+1U | R. S. Abhari, A. Steinfeld |
Abstract
Technical applications of engineering thermodynamics. Extension of thermodynamical fundamentals taught in Thermodynamics I and II.

Objective
Understand and apply thermodynamic principles and processes for use in a range of cycles used commonly in practice.

Content

 Fluid Dynamics II | O | 3 credits | 2V+1U | P. Jenny |
Abstract
Two-dimensional irrotational (potential) flows: stream function and potential, singularity method, unsteady flow, aerodynamic concepts.

Vorticity dynamics: vorticity and circulation, vorticity equation, vortex theorems of Helmholtz and Kelvin.

Compressible flows: isentropic flow along stream tube, normal and oblique shocks, Laval nozzle, Prandtl-Meyer expansion, viscous effects.

Objective
Expand basic knowledge of fluid dynamics.

Concepts, phenomena and quantitative description of irrotational (potential), rotational, and one-dimensional compressible flows.

Content
Two-dimensional irrotational (potential) flows: stream function and potential, complex notation, singularity method, unsteady flow, aerodynamic concepts.

Vorticity dynamics: vorticity and circulation, vorticity equation, vortex theorems of Helmholtz and Kelvin.

Compressible flows: isentropic flow along stream tube, normal and oblique shocks, Laval nozzle, Prandtl-Meyer expansion, viscous effects.

Lecture notes
Lecture notes are available (in German).

(See also info on literature below.)

Literature
Relevant chapters (corresponding to lecture notes) from the textbook


Electives

Number | Title | Type | ECTS | Hours | Lecturers |
--- | --- | --- | --- | --- | --- |
151-0917-00L | Mass Transfer | W | 4 credits | 2V+2U | R. Büchel, S. E. Pratsinis |
Abstract
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Objective
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.
The objective of the course is to provide undergraduate and graduate students in MAVT with an understanding of the use of economic theory and methods to business and economic decision-making. Economic ideas related to production, pricing, and consumer behavior are used to solve management decision problems. The course covers a number of models and methods of analysis which are commonly employed in business decisions. The course covers the economic theory of choice, models of oligopoly and industrial organization, applications of game theory to contract design and agency theory, and the theory of decision making under uncertainty focusing specifically on long-term investment decisions. The course will include three lectures by Professor Volker Hoffman focusing on related case-studies in management.

Literature
Mikroökonomie (Pearson Studium - Economic VWL) Gebundene Ausgabe, August 2013, Robert S. Pindyck, Dr. Daniel L. Rubinfeld.

Prerequisites / notice
Not for MSc students belonging to D-MTEC!
Content
Initial value problems for ODE: review of basic theory for ODEs, Forward and Backward Euler methods, Taylor series methods, Runge-Kutta methods, basic stability and consistency analysis, numerical solution of stiff ODEs.

Two-point boundary value problems: Green's function representation of solutions, Maximum principle, finite difference schemes, stability analysis.

Elliptic equations: Laplace's equation in one and two space dimensions, finite element methods, implementation of finite elements, error analysis.


Hyperbolic equations: Linear advection equation, method of characteristics, upwind schemes and their stability. Burgers equation, scalar conservation laws, shocks and rarefactions, Riemann problems, Godunov type schemes, TVD property.

Lecture notes
Script will be provided.

Literature
Chapters of the following book provide supplementary reading and are not meant as course material:

Prerequisites / notice
(Suggested) Prerequisites:
Analysis I-III (for D-MAVT), Linear Algebra, CMEA I, basic familiarity with programming in C++.

151-3207-00L Lightweight
\[ \text{Abstract} \]
The elective course Lightweight includes numerical methods for the analysis of the load carrying and failure behavior of lightweight structures, as well as construction methods and design principles for lightweight design.

\[ \text{Objective} \]
The goal of this course is to convey substantiated background for the understanding and the design and sizing of modern lightweight structures in mechanical engineering, vehicle and airplane design.

\[ \text{Content} \]
Lightweight design
Thin-walled beams and structures
Instability behavior of thin walled structures
Reinforced shell structures
Load introduction in lightweight structures
Joining technology
Sandwich design

Lecture notes
Script, Handouts, Exercises

Focus Project
Focus Projects in Mechatronics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0073-10L</td>
<td>Amphibious Robot</td>
<td>W</td>
<td>0</td>
<td>15A</td>
<td>R. Siegwart</td>
</tr>
</tbody>
</table>

This course is part of a one-year course. The 14 credit points will be issued at the end of FS2017 with new enrolling for the same Focus-Project in FS2017.

For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:
a. Basis examination successfully passed
b. Block 1 and 2 successfully passed

Abstract
Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

Objective
The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
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- Ability to make decisions, implementation skills
- Workshop and industrial contacts
- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

Prerequisites / notice
This Focus-Project is supervised by the following lecturers: Siegwart, R., ASL
Haas, R., ASL

151-0073-20L Mechanically-Actuated Cartoon Face
\[ \text{Abstract} \]
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Prerequisites / notice
This Focus-Project is supervised by the following lecturers:
Siegwart, R., ASL
Haas, R., ASL
Beardsley P., Disney Research Zurich

151-0073-30L  Robo-Racer  W  0 credits  15A  R. Siegwart, M. Hutter

For MAVT BSc and ITET BSc only.

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Prerequisites / notice
This Focus-Project is supervised by the following lecturers:
Siegwart, R., ASL
Haas, R., ASL
Beardsley P., Disney Research Zurich

151-0073-40L  Adaptive Helicopter Landing Gear  W  0 credits  15A  M. Hutter

For MAVT BSc and ITET BSc only.

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Content
Several teams of 4-8 students of the ETH as well as students from other universities realize a product during two semesters. On the basis of a vision and provocative problem definition, all processes of product development are beat down close-to-reality: conception, design, engineering, simulation, draft and production. The teams are coached by experienced staff who gives them the possibility of a unique learning experience.
Innovative ideas of the research labs of the ETH, of industrial partners or students are selected and realized by the teams.

>>> Focus Projects in Manufacturing

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<td>151-0075-10L</td>
<td>SUNCAR - iRoadster - Chassis</td>
<td>W</td>
<td>0</td>
<td>15A</td>
<td>K. Wegener</td>
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- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM) 
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151-0075-20L Formula Student Electric - Chassis and Suspension

This course is part of a one-year course. The 14 credit points will be issued at the end of FS2017 with new enrolling for the same Focus-Project in FS2017.

For MAVT BSc and ITET BSc only.

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Prerequisites / notice

This Focus-Project is supervised by the following lecturers:
Hora, P.
Heingärtner, J.

151-0075-30L SUNCAR - iRoadster - Antrieb

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For MAVT BSc and ITET BSc only.

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151-0075-40L Formula Student Electric - Drivetrain

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For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:

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Autumn Semester 2016
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Innovative ideas of the research labs of the ETH, of industrial partners or students are selected and realized by the teams.

Prerequisites / notice

This Focus-Project is supervised by the following lecturers:
Hora, P.
Heingärtner, J.

151-0075-50L Sustainable Materials Concept

This course is part of a one-year course. The 14 credit points will be issued at the end of FS2017 with new enrolling for the same Focus-Project in FS2017.

For MAVT BSc and ITET BSc only.

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151-0079-20L SeatCase - An Innovative Airline Seat

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151-0079-30L Airborne Wind Energy System

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For MAVT BSc and ITET BSc only.

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151-0079-40L
CFLF System: Free Form 3D Printing of Fibre Composite Structures
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151-0079-52L
Skinfactory BioReactor
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Courses Eligible for Focus Projects

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<tr>
<td>151-0141-00L</td>
<td>Leadership</td>
<td>W</td>
<td>1 credit</td>
<td>2G</td>
<td>K. Wegener, A. Halbleib</td>
</tr>
</tbody>
</table>

Only students for focus projects or doctoral students.

Abstract
Introduction in the topic of leading work forces. In the framework of scenarios competences and knowledge concerning leadership will be developed interactively with the students. Motivation, goal orientation and success will be discussed. The reliability of leaders is part of the course.

Objective
Culture of leading and corporate governance.

Content
Introduction in the topic of leading work forces.

Prerequisites / notice
Only students for focus projects or doctoral students.
Practice Course to Focus Projects on Product Development

Only students for focus projects. 2 up to 3 students per focus project.

Abstract
This course provides comprehensive input to ongoing focus project teams in the areas of project management, communication and presentation, as well as dealing with the media, coaches and patents and safety issues.

Objective
Participants will receive tips, hints and background information from experienced tutors applicable to current projects.

Content
Project Management
- Creating a solid project base
- Project planning and controlling
- Product validation and testing
- Problem solving cycle and decision taking transparent for others

Communication
- Public Relations in a Nutshell
- How to acquire and manage suppliers and sponsors
- Technical reports
- Review presentations
- Handling of and guidance to
  - Expectation management and dealing with conflicts
  - Safety issues
  - Issues regarding patents

Lecture notes
Lecture notes and documentation will be electronically available.

Prerequisites / notice
- only for students participating in a Focus Project in the same semester

Practice Course to Focus Projects on CAD and CAE
Based on Siemens NX

Number of participants limited to 40.

Abstract
This course provides comprehensive input to ongoing Focus Projects teams in the areas of CAD and CAE with Siemens NX.

Objective
Participants will receive tips, hints and background information from experienced tutors applicable to current projects.

Content
CAD with Siemens NX
- 2 day of intensive training (2x4h, 1x8L)

CAE mit Siemens NX
- 2 separate days of intensive training (2x8L)

Lecture notes
Lecture notes and documentation will be electronically available.

Prerequisites / notice
- only for students participating in a Focus Project in the same semester
- not more than 40 students
- use of Siemens NX CAD/CAE in the corresponding Focus Project required

Product Design for Focus Projects

Number of participants limited to 30.

Abstract
This course introduces students to fundamental topics in product design and development specifically directed towards focus project students. The course will be taught using the students’ focus projects as the main case study during the hands-on exercises.

Objective
The objectives of the course are to introduce students to the most important topics in product design and development focusing on the early design phases and conceptual design methods. A further goal is to develop design reasoning and critical thinking skills important for focus projects.

Content
The content of the course will follow a product design and development process that is introduced. The focus will be on the concept design phase including design task definition, understanding users, product specifications, concept design methods, product architecture, industrial design, prototyping methods, design for manufacture and a review of technical drawing and norms.

Lecture notes
available on Moodle

Focus Specialization

Energy, Flows and Processes

Focus Coordinator: Prof. Christoph Müller

In order to achieve the required 20 credit points for the Focus Specialization Energy, Flows and Processes you need to choose at least 2 of the 4 compulsory courses (HS/FS) and at least 2 of the electives courses (HS/FS). One course could be selected among all the courses offered by D-MAVT (Bachelor and Masters).

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<tr>
<td></td>
<td>Compulsory Courses</td>
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<tr>
<td>151-0123-00L</td>
<td>Experimental Methods for Engineers</td>
<td>W+</td>
<td>4</td>
<td>2V+2U</td>
<td>T. Rössgen, R. S. Abhari,</td>
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<td></td>
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<td></td>
<td>K. Boulouchos, D. J. Norris,</td>
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<td>H.M. Prasser, A. Steinfeld</td>
</tr>
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Abstract
The course presents an overview of measurement tasks in engineering environments. Different concepts for the acquisition and processing of typical measurement quantities are introduced. Following an initial in-class introduction, laboratory exercises from different application areas (especially in thermofluidics and process engineering) are attended by students in small groups.
Objective
Introduction to various aspects of measurement techniques, with particular emphasis on thermo-fluidic applications. Understanding of various sensing technologies and analysis procedures. Exposure to typical experiments, diagnostics hardware, data acquisition and processing. Study of applications in the laboratory.

Content
- In-class introduction to representative measurement techniques in the research areas of the participating institutes (fluid dynamics, energy technology, process engineering)
- Student participation in 8-10 laboratory experiments (study groups of 3-5 students, dependent on the number of course participants and available experiments)
- Lab reports for all attended experiments have to be submitted by the study groups.
- A final exam evaluates the acquired knowledge individually.

Lecture notes
Presentations, handouts and instructions are provided for each experiment.

Literature

Prerequisites / notice
Basic understanding in the following areas:
- fluid mechanics, thermodynamics, heat and mass transfer
- electrical engineering / electronics
- numerical data analysis and processing (e.g. using MATLAB)

151-0293-00L  Combustion and Reactive Processes in Energy and Materials Technology
4 credits 2V+1U+2A K. Boulouchos, F. Ernst, Y. M. Wright

Abstract
The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials.

Objective
The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials. The lecture is part of the focus "Energy, Flows & Processes" on the Bachelor level and is recommended as a basis for a future Master in the area of energy. It is also a facultative lecture on Master level in Energy Science and Technology and Process Engineering.

Content

Lecture notes
HANDBOUTS are EXCLUSIVELY IN GERMAN ONLY, however recommendations for English text books will be provided.

Literature
TEACHING LANGUAGE IN CLASS is German OR English (ON DEMAND).


Elective Courses

151-0109-00L  Turbulent Flows
W  4 credits 2V+1U P. Jenny

Abstract
The students should become familiar with the fundamentals of turbulent flow computation and elements of turbulence modelling

Objective
Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation.

Content
- Properties of laminar and turbulent flows.
- Origin and control of turbulence. Instability and transition.
- Statistical description, averaging, equations for mean and fluctuating quantities, closure problem.
- Scourings, homogeneous isotropic turbulence, energy spectrum.
- Turbulent shear flows. Jet, wake, mixing layer.
- Wall-bounded turbulent flows.

Lecture notes
Lecture notes are available

Literature

151-0235-00L  Thermodynamics of Novel Energy Conversion Technologies
W  4 credits 3G C. S. Sharma, D. Poulikakos, G. Sansavini

Abstract
In the framework of this course we will look at current electronic thermal and energy management strategies and novel energy conversion processes. The course will focus on component level fundamentals of these process and system level analysis of interactions among various energy conversion components.

Objective
This course deals with liquid cooling based thermal management of electronics, reuse of waste heat and novel energy conversion and storage systems such as batteries, fuel cells and micro-fuel cells. The focus of the course is on the physics and basic understanding of those systems as well as their real-world applications. The course will also look at analysis of system level interactions between a range of energy conversion components.

Content
Part 1: Fundamentals:
- Overview of exergy analysis, single phase liquid cooling and micro-mixing;
- Thermodynamics of multi-component-systems (mixtures) and phase equilibrium;
- Electrochemistry;

Part 2: Applications:
- Basic principles of battery;
- Introduction to fuel cells;
- Reuse of waste heat from supercomputers;
- Hotspot targeted cooling of microprocessors;
- Microfluidic fuel cells

Part 3: System-level analysis
- Integration of the components into the system: a case study
- Analysis of the coupled operations, identification of critical states
- Support to system-oriented design

Lecture notes
Lecture slides will be made available. Lecture notes will be available for some topics (in English).
Overview of Mechatronics topics and study subjects. Identification of minimum 10 pertinent refereed articles or works in the literature in this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid understanding. Acoustophoresis, the design of devices and potential applications.

2V+2U

Professors

P. Rudolf von Rohr

Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's master the basics of signals and systems. Apply this knowledge to problems in the homework assignments and programming exercise.


R. Büchel


Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria for multiphase systems; introduction into mechanical process engineering and particle technology.

Lecturers

Professors

P. Rudolf von Rohr, C. Müller

Fundamentals in Process Engineering W 4 credits 2V+2U

Objective

To expound fundamentals in process engineering.

Content

Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria for multiphase systems; introduction into mechanical process engineering and particle technology script in German available.

Lecture notes

Fundamentals in Process Engineering

Additional Case for the Focus Specialization

Exclusive for D-MAVT Bachelor's students in Focus Specialization.

For enrollment, please contact the D-MAVT Student Administration

Abstract

Independent studies on a defined field within the selected Focus Specialization.

Objective

Independent studies on a defined field within the selected Focus Specialization.

Prerequisites / notice

Hanspeter Graber, R. Büchel, P. Rudolf von Rohr

Mechatronics

Focus Coordinator: Prof. Bradley Nelson

To achieve the 20 credits for Focus Specialization Mechatronics, 151-0640-00L Studies on Mechatronics is compulsory.

Number Title Type ECTS Hours Lecturers

151-0640-00L Studies on Mechatronics O 5 credits 11A Professors

The following professors can be chosen and please contact the professor directly:


This course is not available to incoming exchange students.

Abstract

Overview of Mechatronics topics and study subjects. Identification of minimum 10 pertinent refereed articles or works in the literature in consultation with supervisor or instructor. After 4 weeks, submission of a 2-page proposal outlining the value, state-of-the-art and study plan based on these articles. After feedback on the substance and technical writing by the instructor, project commences.

Objective

The students are familiar with the challenges of the fascinating and interdisciplinary field of Mechatronics and Mikrosystems. They are introduced in the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently. The students work independently on a study of selected topics in the field of Mechatronics or Microsystems. They start with a selection of scientific papers to continue literature research. The results (e.g. state-of-the-art, methods) are evaluated with respect to predefined criteria. Then the results are presented in an oral presentation and summarized in a report, which takes the discussion of the presentation into account.

Content

Studies on Mechatronics

Prerequisites / notice

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This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.
Objective

The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and de-sign safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

Content

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Students will attend laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://www.relab.ethz.ch/education/courses/phri/request-ethz-haptic-paddle-hardware-documentation.html), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.

Lecture notes

Will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/phri.html

Literature


Prerequisites / notice

Notice:
The registration is limited to 26 students
There are 4 credit points for this lecture.
The lecture will be held in English.
The students are expected to have basic control knowledge from previous classes.

http://www.relab.ethz.ch/education/courses/phri.html

151-0135-00L Additional Case for the Focus Specialization ■ W 1 credit 2A Professors

Exclusive for D-MAVT Bachelor's students in Focus Specialization.
For enrollment, please contact the D-MAVT Student Administration.

Abstract

Independent studies on a defined field within the selected Focus Specialization.

Objective

Independent studies on a defined field within the selected Focus Specialization.

Microsystems and Nanoscale Engineering
Introduction to Nanoscale Engineering

**Microrobotics**

Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

**Objective**

The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

**Content**

Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

**Lecture notes**

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

**Prerequisites / notice**

The lecture will be taught in English.

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**Introduction to Nanoscale Engineering**

*This class is strictly only for BSc MAVT student.*

**Objective**

This course aims to familiarize BSc students with some of the basic phenomena of nanoscale, thereby illustrating the links between physics, chemistry, materials science and/or biology through hands-on experience. Furthermore it aims to give an overview of the field with motivating lectures from industry and academia, including the development of technologies and processes based on or involving nanoscale phenomena. Most importantly, this course aims to develop the creativity and sharpen the communication skills of the students through their individual projects, a PERFEKT search, effective oral/written project presentations), the future profession itself and even life, in general, as the abc questions (in the Content below) are always there!

**Content**

This is strictly a BSc course. Its objectives are met primarily through the individual student project which may involve experiments, simulations or critical & quantitative reviews of the literature. Therein, a 2-page proposal (15% of the grade) is submitted within the first two semesters weeks addressing explicitly, at least, 10 well-selected research articles and thoughtful meetings with the project supervisor. The proposal address 3 basic questions: a) how important is the project; b) what has been done already in that field and c) what will be done by the student. Detailed feedback on each proposal is given by the supervisor, assistant and professor two weeks later. Towards the end of the semester, a 10-minute oral presentation is given by the student followed 10 minutes Q&A (30% of the grade). A 10-page final report is submitted by noon of the last day of the semester (55% of the grade). The project supervisor will provide guidance throughout the course especially when called for by the student. Detailed feedback on each proposal, presentation and final report is given by the supervisor, assistant and professor.

Course lectures will include some, if not all, of the following:
- Overview of Nanotechnology & Project Presentation
- Control of nanoparticle size & structure in the gas-phase
- Multi-scale design of nanomaterial synthesis
- Characterization of nanostructured materials
- Encapsulation technologies for active food ingredients
- Aerosol manufacture of nanoparticles
- Physical Chemistry of Nanoparticles (structure, molecular forces, statistical thermodynamics)
- Thermodynamics of nanoparticles, (the basics, thermal stability, nanophases, melting temperature)
- Transport properties of nanoparticles (diffusivity, mobility, settling, adsorption)
- Computer simulations of nanoparticles (from atoms, to primary particles, to agglomerates)
- Thin film coatings
- Cluster beam deposition
- Coaching for proposal & report writing as well as oral presentations

**Prerequisites / notice**

5th semester student standing in D-MAVT. Students attending this course are expected to allocate sufficient additional time within their weekly lecture schedule in order to successfully conduct the project work. As exceptional effort will be required, having seen “Chasing Mavericks” (2012) by Apted & Henson, "Unbroken" (2014) by Angelina Jolie and, in particular, "The Salt of the Earth" (2014) by Wim Wenders might be helpful and even motivating. These movies show how methodic effort can bring superior and truly unexpected results (e.g. stay under water for 5 minutes to overcome the fear of riding huge waves or merciless Olympic athlete training that help him survive 45 days on a raft in Pacific Ocean followed by 2 years in a Japanese POW camp during WWII).

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**Microsystems Technology**

Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and -devices by a sequence of defined processing steps (process flow).

**Objective**

Students are introduced to the basics of micromachining and silicon process technology and will understand the fabrication of microsystem devices by the combination of unit process steps. The course concludes with an end-of-semester examination.

**Content**

- Introduction to Microsystems technology (MST) and micro electro mechanical systems (MEMS)
- Basic silicon technologies: Thermal oxidation, photolithography and etching, diffusion and ion implantation, thin film deposition.
- Specific microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresistive materials.
- Selected Microsystems: Mechanical sensors and actuators, microresonators, thermal sensors and actuators, system integration and encapsulation.

**Lecture notes**

Handsouts (available online)

**Literature**

- S.M. Sze: Semiconductor Devices, Physics and Technology
- W. Menz, J. Mohr, O.Paul: Microsystems Technology
- G. Kovacs: Micromachined Transducer Sourcebook

**Prerequisites / notice**

Prerequisites: Physics I and II

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**Studies on Micro and Nano Systems**

Please contact one of the following professors directly:
- J. Dual, C. Hierold, B. Nelson, D. Norris, D. Poulikakos,
This course is not available to incoming exchange students.

Abstract
The students get familiarized with the challenges of the fascinating and interdisciplinary field of Micro- and Nanosystems. They are introduced to the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.

Objective
The students get familiarized with the challenges of the fascinating and interdisciplinary field of Micro- and Nanosystems. They are introduced to the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.

Content
Students work independently on a study of selected topics in the field of Micro- and Nanosystems. They start with a selection of scientific papers, and continue with an independent literature research. The results (e.g. state-of-the-art, methods) are evaluated with respect to predefined criteria. Then the results are presented in an oral presentation and summarized in a report, which takes the discussion of the presentation into account.

Literature
Literature will be provided

151-0911-00L Introduction to Plasmonics W 4 credits 2V+1U D. J. Norris

Abstract
This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.

Objective
Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

Content
Fundamentals of Plasmonics
- Basic electromagnetic theory
- Optical properties of metals
- Surface plasmon polaritons on surfaces
- Surface plasmon polariton propagation
- Localized surface plasmons

Applications of Plasmonics
- Wavesguides
- Extraordinary optical transmission
- Enhanced spectroscopy
- Sensing
- Metamaterials

Lecture notes
Class notes and handouts

Literature

Prerequisites / notice
Physics I, Physics II

151-0135-00L Additional Case for the Focus Specialization W 1 credit 2A Professors

Abstract
Exclusive for D-MAVT Bachelor's students in Focus Specialization.

For enrollment, please contact the D-MAVT Student Administration.

Objective
Independent studies on a defined field within the selected Focus Specialization.

Content
Independent studies on a defined field within the selected Focus Specialization.

Manufacturing Science
Focus Coordinator: Prof. Konrad Wegener
To achieve the required 20 credit points for the focus specialization you need to pass all 3 compulsory courses (HS/FS). The other 8 credit points can be achieved from the elective courses.

Number Title Type ECTS Hours Lecturers
151-0705-00L Manufacturing I O 4 credits 2V+2U K. Wegener, M. Boccadoro, F. Kuster

Abstract
Deeper insight in manufacturing processes: drilling, milling, grinding, honing, lapping, electro erosion and electrochemical machining.

Objective
Stability of processes, process chains and process choice.

Content
Deepened discussion on the machining processes and their optimisation. Outlook on additional areas such as NC-Technique, dynamics of processes and machines, chatter as well as process monitoring.

Lecture notes
yes

Prerequisites / notice
Prerequisites: Recommendation: Lecture 151-0700-00L Manufacturing elective course in the 4th semester.

Language: Help for English speaking students on request as well as english translations of the slides shown.

151-0733-00L Forming Technology III - Forming Processes O 4 credits 2V+2U F. Kuster

Abstract
The lecture teaches on the basic knowledge of major processes in sheet metal, tube and bulk metal forming technologies. In particular it focuses on fundamental computation methods, which allow a fast assessment of process behaviour and a rough layout. Process-specific states of stress and deformation are analysed and process limits are identified.

Objective
Acquaintance with forming processes. Determination of forming processes. Interpretation of forming manufacturing limits and machining accuracy; tools and operation; machinery and machine usage.

Content
The study of metal working processes: sheet metal forming, folding die cutting, cold bulk metal forming, ro extrusion, plunging, open die forging, drop forging, milling; active principle; elementary methods to estimate stress and strain; fundamentals of process design; manufacturing limits and machining accuracy; tools and operation; machinery and machine usage.

Lecture notes

151-0573-00L System Modeling W 4 credits 2V+2U G. Ducard, C. Onder

Abstract

Objective
### Content
Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data. Examples: mechatronic, thermodynamic, chemistry, fluid dynamic, energy, and process engineering systems. Model scaling, linearization, order reduction, and balancing. Estimation techniques (least-squares methods).

Class case studies: Loud-speaker, Water-propelled rocket, geostationary satellites, etc.

The exercises address practical examples. One larger case study is to be solved.

### Lecture notes
The handouts in English will be sold in the first lecture.

### Literature
A list of references is included in the handouts.

### 151-0703-00L
**Operational Simulation of Production Lines**  
**W+** 4 credits  **2V+1U**  
**P. Acél**

**Abstract**
The student learns the application of the event-driven and computer-based simulation for layout and operational improvement of production facilities by means of practical examples.

**Objective**
The student learns the right use of (Who? When? How?) of the event-driven and computer-based simulation in the illustration of the operating procedures and the production facilities.

Operating simulation in the productions, logistic and scheduling will be shown by means of practical examples.

The student should make his first experiences in the use of computer-based simulation.

**Content**
- Application and application areas of the event-driven simulation
- Exemplary application of a software tool (Technomatrix-Simulation-Software)
- Internal organisation and functionality of simulation tools
- Procedure for application: optimizing, experimental design planning, analysis, data preparation
- Controlling philosophies, emergency concepts, production in sequence, line production, rescheduling
- Application on the facilities projecting

**Lecture notes**
The knowledge is enhanced by practice-oriented exercises and an excursion. A guest speaker will present a practical example.

**Prerequisites / notice**
Recommended for all Bachelor-Students in the 5th semester and Master-Students in the 7th semester.

### 151-0717-00L
**Mechanical Production: Assembly, Joining and Coating Technology**  
**W+** 4 credits  **2V+1U**  
**F. Kuster, V. H. Derflinger, F. Durand, P. Jousset**

**Abstract**
Understanding of the complexity of the assembly process as well as its meaning as success and cost factor. The assembly with the different aspects of adding, moving, adjusting, controlling parts etc... Adding techniques; solvable and unsolvable connections. Assembly plants. Coating techniques and their tasks, in particular corrosion protection.

- Application on the facilities projecting
- Controlling philosophies, emergency concepts, production in sequence, line production, rescheduling
- Procedure for application: optimizing, experimental design planning, analysis, data preparation
- Internal organisation and functionality of simulation tools
- Controlling philosophies, emergency concepts, production in sequence, line production, rescheduling
- Application on the facilities projecting

**Objective**
To understand assembly in its full complexity and its paramount importance regarding cost and financial success. An introduction into a choice of selected joining and coating techniques.

**Content**
- Assembly as combination of several classes of action like, e.g., joining, handling, fine adjustments, etc. Techniques for joining objects temporarily or permanently. Assembly systems.
- Coating processes and their specific applications, with particular emphasis on corrosion protection.

**Lecture notes**
Yes

**Prerequisites / notice**
Recommended to the focus production engineering.

Majority of lecturers from the industry.

### 151-0719-00L
**Quality of Machine Tools - Dynamics and Metrology at Micro and Submicro Level**  
**W+** 4 credits  **2V+1U**  
**W. Knapp, F. Kuster**

**Abstract**
The course "Machine tool metrology" deals with the principal design of machine tools, their spindles and linear axes, with possible geometric, kinematic, thermal and dynamic errors of machine tools and testing these errors, with the influence of errors on the workpiece (error budgeting), with testing of drives and numerical control, as well as with checking the machine tool capability.

**Objective**
Knowledge of
- principal design of machine tools
- errors of linear and rotational axes and of machine tools,
- influence of errors on the workpiece (error budgeting)
- dynamics of mechanical systems
- geometric, kinematic, thermal, dynamic testing of machine tools
- test uncertainty
- machine tool capability

**Content**
- Metrology for production, machine tool metrology
- basics, like principal machine tool design and machine tool coordinate system
- principal design and errors of linear and rotational axes
- error budgeting, influence of machine errors on the workpiece
- geometric and kinematic testing of machine tools
- reversal measurement techniques, multi-dimensional machine tool metrology
- thermal influences on machine tools and testing these influences
- test uncertainty, simulation
- dynamics of mechanical systems, dynamic error sources
- machine tool dynamics and the engineering tools modal analysis and finite element method (FEM)
- testing of drives and numerical control
- machine tool capability

**Lecture notes**
Documents are provided during the course. English handouts available on request.

**Prerequisites / notice**
Exercises in the laboratories and with the machine tools of the institute for machine tools and manufacturing (IWF) provide the practical background for this course.

### 151-0723-00L
**Manufacturing of Electronic Devices**  
**W+** 4 credits  **3G**  
**A. Kunz, A. Guber, R.D. Moryson, F. Reichert**

**Abstract**
The lecture follows the value added process sequence of electric and electronic components. It contains: Development of electric and electronic circuits, design of electronic circuits on printed circuit boards as well as in hybrid technology, integrated test technology, planning of production lines, production of highly integrated electronic on a wafer as well as recycling.

**Objective**
Knowledge about the value added process sequence for electronics manufacturing, planning of electric and electronic product as well as their production, planning of production lines, value added process sequence for photovoltaics.
The fundamentals of forming technology are presented to Mechanical, Production and Material Engineers. The content of the lecture is:

- Overview of the most important processes of metal-forming technology and its field of applications, characterization of the plastic metal-forming behavior, basic principles of plastic-mechanical calculations, metal-forming residual stresses, thermo-mechanical coupling of metal-forming processes, influence of tribology. Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery.

Lecture notes Notice

Lecture notes are handed out during the individual lessons (CHF 20.).

Prerequisites / Notice

Help for English speaking students on request.

The lecture is partly given by experts from industry. It is supplemented by an excursion to one of the industry partners.

151-0731-00L Forming Technology I - Basic Knowledge

Abstract

The fundamentals of forming technology are presented to Mechanical, Production and Material Engineers. The content of the lecture is:

Overview of manufacturing with forming techniques, deformation specific description of material properties and their experimental measurement, material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure.

Objective

Forming technology represents with its 70% global share in manufactured metal volume with respect to yield and cost, the most important manufacturing process in metal-working industries. Typical applications of forming technology range from the manufacturing of sheet metal components in auto bodies to applications in food and pharma packaging, fabrication of implants in medical technologies and to the fabrication of leads in microelectronic components. This course introduces the fundamentals which are essential to evaluate metal-forming processes and its industrial applications. This includes, together with the acquirements of the most important forming processes, the characterization of plastic material behavior and manufacturing limits.

Content

Overview of the most important processes of metal-forming technology and its field of applications, characterization of the plastic metal-forming behavior, basic principles of plastic-mechanical calculations, metal-forming residual stresses, thermo-mechanical coupling of metal-forming processes, influence of tribology. Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery.

Lecture notes

Dynamic Behavior of Materials and Structures

Abstract

Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme loadings during manufacturing, crash, impact and blast events.

Objective

Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering.

Content

Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;

Lecture notes

Slides of the lectures, relevant journal papers and users manuals will be provided.

Literature

Various books will be recommended covering the topics discussed in class

Prerequisites / Notice

Course in continuum mechanics (mandatory), finite element method (recommended)

151-0833-00L Principles of Nonlinear Finite-Element-Methods

Abstract

Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.

Objective

The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:

- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations

Content

- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

Lecture notes

yes

Literature


Prerequisites / Notice

If we will have a large number of students, two dates for the exercises will be offered.

227-0113-00L Power Electronics

Abstract

Fields of application of power electronic systems. Principle of operation of basic pulse-width modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

W
5 credits

The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

Lecture notes
Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.

Prerequisites / notice
Prerequisites: Basic knowledge of electric circuit analysis and signal theory.

Autumn Semester 2016

Energy Conversion and Transport in Biosystems

Number
151-0255-00L

Title
Energy Conversion and Transport in Biosystems

Type
W

ECTS
4 credits

Hours
2V+1U

Lecturers
D. Poulikakos, A. Ferrari

Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation.

Lecture notes
Lecture notes and references therein.

Number of participants limited to 30.

Microacoustofluidics

Number
151-0509-00L

Title
Microacoustofluidics

Abstract
In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

Objective
Understanding acoustophoresis, the design of devices and potential applications.

Content
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microrobotics to surface acoustic wave devices

Lecture notes

Literature

Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

Microrobotics

Number
151-0524-00L

Title
Microrobotics

Abstract
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

Objective
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Content
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

Lecture notes
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

Prerequisites / notice
The lecture will be taught in English.

Introduction to Nanoscale Engineering

Number
151-0619-00L

Title
Introduction to Nanoscale Engineering

Abstract
Nano is the new scale in science & engineering as micro was ~150 years ago. This BSc course demands substantial effort! It gives a flavor of nanotechnology with hands-on student projects on gas-phase synthesis of nanoparticles & applications in catalysis, gas sensing and biomedical engineering. Projects are conducted individually under the close supervision of MSc, PhD or post-doctoral students.

This class is strictly only for BSc MAVT student.
This course aims to familiarize BSc students with some of the basic phenomena of nanoscale, thereby illustrating the links between physics, chemistry, materials science and/or biology through hands-on experience. Furthermore it aims to give an overview of the field with motivating lectures from industry and academia, including the development of technologies and processes based on or involving nanoscale phenomena. Most importantly, this course aims to develop the creativity and sharpen the communication skills of the students through their individual projects, a PERFECT preparation for the BSc thesis (i.e. efficient literature search, effective oral/written project presentations), the future profession itself and even life, in general, as the abc questions (in the Content below) are always there!

This is strictly a BSc course. Its objectives are met primarily through the individual student project which may involve experiments, simulations or critical & quantitative reviews of the literature. Thereina, a 2-page proposal (15% of the grade) is submitted within the first two semester weeks addressing explicitly, at least, 10 well selected research articles and thoughtful meetings with the project supervisor. The proposal might address 3 basic questions: a) how important is the project; b) what has been done already in that field and c) what will be done by the student. Detailed feedback on each proposal is given by the supervisor, assistant and professor two weeks later. Towards the end of the semester, a 10-minute oral presentation is given by the student followed 10 minutes Q&A (30% of the grade). A 10-page final report is submitted by noon of the last day of the semester (55% of the grade). The project supervisor will provide guidance throughout the course especially when called for by the student. Detailed feedback on each proposal, presentation and final report is given by the supervisor, assistant and professor.

Course lectures will include some, if not all, of the following:
- Overview of Nanotechnology & Project Presentation
- Control of nanoparticle size & structure in the gas-phase
- Multi-scale design of nanomaterial synthesis
- Characterization of nanostructured materials
- Encapsulation technologies for active food ingredients
- Aerosol manufacture of nanoparticles
- Physical Chemistry of Nanoparticles (structure, molecular forces, statistical thermodynamics)
- Thermodynamics of nanoparticles (the basics, thermal stability, nanophases, melting temperature)
- Transport properties of nanoparticles (diffusivity, mobility, settling, adsorption)
- Computer simulations of nanoparticles (from atoms, to primary particles, to agglomerates)
- Thin film coatings
- Cluster beam deposition
- Coaching for proposal & report writing as well as oral presentations

5th semester student standing in D-MAVT. Students attending this course are expected to allocate sufficient additional time within their weekly lecture schedule in order to successfully conduct the project work. As exceptional effort will be required, having seen “Chasing Mavericks” (2012) by Apted & Henson, “Unbroken” (2014) by Angelina Jolie and, in particular, “The Salt of the Earth” (2014) by Wim Wenders might be helpful and even motivating. These movies show how methodic effort can bring superior and truly unexpected results (e.g. stay under water for 5 minutes to overcome the fear of riding huge waves or merciless Olympic athlete training that help him survive 45 days on a raft in Pacific Ocean followed by 2 years in a Japanese POW camp during WWII).

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<tbody>
<tr>
<td>151-0621-00L</td>
<td>Microsystems Technology</td>
<td>W 6</td>
<td>4G</td>
<td>C. H. H. J. A. M. H. R. S. H. L.</td>
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<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W 6</td>
<td>5G</td>
<td>S. K. K. P. R. P. R. U.</td>
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<tr>
<td>227-0393-10L</td>
<td>Bioelectronics and Biosensors</td>
<td>W 6</td>
<td>2V+2U</td>
<td>J. V. O. R. M. F. Y. N. T. Z. M.</td>
</tr>
</tbody>
</table>
Content

L1. Bioelectronics history, its applications and overview of the field
- Volta and Galvani dispute
- BMI, pacemaker, cochlear implant, retinal implant, limb replacement devices
- Fundamentals of biosensing
- Glucometer and ELISA

L2. Fundamentals of quantum and classical noise in measuring biological signals

L3. Biomeasurement techniques with photons

L4. Acoustics sensors
- Differential equation for quartz crystal resonance
- Acoustic sensors and their applications

L5. Engineering principles of optical probes for measuring and manipulating molecular and cellular processes

L6. Optical biosensors
- Differential equation for optical waveguides
- Optical sensors and their applications
- Plasmonic sensing

L7. Basic notions of molecular adsorption and electron transfer
- Quantum mechanics: Schrödinger equation energy levels from H atom to crystals, energy bands
- Electron transfer: Marcus theory, Gerischer theory

L8. Potentiometric sensors
- Fundamentals of the electrochemical cell at equilibrium (Nernst equation)
- Principles of operation of ion-selective electrodes

L9. Amperometric sensors and bioelectric potentials
- Fundamentals of the electrochemical cell with an applied overpotential to generate a faraday current
- Principles of operation of amperometric sensors
- Ion flow through a membrane (Fick equation, Nernst equation, Donnan equilibrium, Goldman equation)

L10. Channels, amplification, signal gating, and patch clamp Y4

L11. Action potentials and impulse propagation

L12. Functional electric stimulation and recording
- MEA and CMOS based recording
- Applying potential in liquid - simulation of fields and relevance to electric stimulation

L13. Neural networks memory and learning

Literature

Plonsey and Barr, Bioelectricity: A Quantitative Approach (Third edition)

Prerequisites /

Supervised exercises solving real-world problems. Some Matlab based exercises in groups.

376-0021-00L Introduction to Biomedical Engineering I W 4 credits 3G P. Christen, R. Müller, J. G. Snedeker, M. Zenobi-Wong

Abstract

Introduction to biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering.

Objective

Understanding of physical and technical principles in biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering. Mathematical description and problem solving. Knowledge of biomedical engineering applications in research and clinical practice.

Content

Tissue and Cellular Biomechanics, Molecular Biomechanics and Biopolymers, Computational Biomechanics, Biomaterials, Tissue Engineering, Radiation and Radiographic Imaging, Diagnostic Ultrasound Imaging, Magnetic Resonance Imaging, Biomedical Optics and Lasers.

Lecture notes

Stored on ILIAS.

Literature


Academic Press

376-0203-00L Movement and Sport Biomechanics W 4 credits 3G B. Taylor, R. List, S. Lorenzetti

Abstract

Learning to view the human body as a (bio-) mechanical system. Making the connections between everyday movements and sports activity with injury, discomfort, prevention and rehabilitation.

Objective

Students are able to describe the human body as a mechanical system.

They analyse and describe human movement according to the laws of mechanics.

Content

Movement- and sports biomechanics deals with the attributes of the human body and their link to mechanics. The course includes topics such as functional anatomy, biomechanics of daily activities (gait, running, etc.) and looks at movement in sport from a mechanical point of view. Furthermore, simple reflections on the loading analysis of joints in various situations are discussed. Additionally, questions covering the statics and dynamics of rigid bodies, and inverse dynamics, relevant to biomechanics are investigated.

376-1504-00L Physical Human Robot Interaction (pHRI) W 4 credits 2V+2U R. Gassert, O. Lambercy

Number of participants limited to 26.

Abstract

This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.
Objective

The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and de-sign safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1. identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2. compare and select mechatronic components that optimally fulfill the defined design requirements;
3. derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4. design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5. characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6. investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

Content

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical-human-robot interaction, laboratory sessions and lab visits.

Weekly lecture sessions will introduce fundamental concepts and will foster a better understanding of the theoretical and practical aspects of physical human-robot interaction. The sessions will provide the basis for understanding the various aspects of the system using a hands-on haptic display. The course will be held in English.

3. Introduction into methodology used in biomaterials research and application.
2. The concept of biocompatibility.
1. Introdcution into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.

Prerequisites / notice

Notice:
The registration is limited to 26 students
There are 4 credit points for this lecture.
The lecture will be held in English.
The students are expected to have basic control knowledge from previous classes.

Lecture notes

Will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/phri.html

Literature


Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1019 of 1571
**Management, Technology, and Economics**

Focus Coordinators: Prof. Marko Köthenbürger D-MTEC and Dr. Jost Hamschmidt D-MTEC

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0733-00L</td>
<td>Forming Technology III - Forming Processes</td>
<td>W</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>P. Hora</td>
</tr>
</tbody>
</table>

**Abstract**

The lecture teaches on the basic knowledge of major processes in sheet metal, tube and bulk metal forming technologies. In particular it focuses on fundamental computation methods, which allow a fast assessment of process behaviour and a rough layout. Process-specific states of stress and deformation are analysed and process limits are identified.

**Objective**

Acquaintance with forming processes. Determination of forming processes. Interpretation of forming manufacturing

**Content**

The study of metal working processes: sheet metal forming, folding die cutting, cold bulk metal forming, ro extrusion, plunging, open die forging, drop forging, rolling; active principle; elementary methods to estimate stress and strain; fundamentals of process design; manufacturing limits and machining accuracy; tools and operation; machinery and machine usage.

**Lecture notes**

Handouts can be accessed online.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>

**Abstract**

Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

**Objective**

Discovering Management combines in an innovative format a set of lectures and an advanced business game. The learning model for Discovering Management involves learning by doing. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.

**Content**

Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the interdependence of various topics in the development and management of a firm. The lectures introduce students not only to topics relevant for managing large corporations, but also touch upon the different aspects of starting up your own venture. The lectures will be presented by the respective area specialists at D-MTEC.

The course broadens the view and understanding of technology by linking it with its commercial applications and with society. The lectures are designed to introduce students to topics related to strategy, corporate innovation, leadership, corporate and entrepreneurial finance, value chain analysis, corporate social responsibility, and business model innovation. Practical examples from industry experts will stimulate the students to critically assess these issues. Creative skills will be trained by the business game exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of Chief Innovation Officer of a large multinational company. As they learn more about the specific case and identify the challenges they are faced with, the students will have to develop an innovative business case for this multinational corporation. Doing so, this exercise will provide an insight into the context of managerial problem-solving and corporate innovation, and enhance the students' appreciation for the complex tasks companies and managers deal with. The business game presents a realistic model of a company and provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyse the future business environment and successfully respond to it by taking systematic decisions, e.g., critical assessment of technological possibilities.

**Prerequisites / notice**

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich.

No prior knowledge of business or economics is required to successfully complete this course.

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>351-0778-01L</td>
<td>Discovering Management (Exercises)</td>
<td>W</td>
<td>1 credit</td>
<td>1U</td>
<td>B. Clarysse, L. De Cuyper</td>
</tr>
</tbody>
</table>

**Abstract**

Complementary exercises for the module Discovering Management.

**Objective**

This course is offered complementary to the module Discovering Management (351-0778-00L) is mandatory.

**Content**

This course is offered complementary to the course 351-0778-00L. The course offers additional exercises and case studies.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>363-0387-00L</td>
<td>Corporate Sustainability</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>V. Hoffmann</td>
</tr>
</tbody>
</table>

Please refer to the course website for further information on the content, credit conditions and schedule of the module: www.dm.ethz.ch
The lectures addresses the assessment of corporate sustainability and its links to strategy, technology, and finance. Students learn why sustainability matters for managers and how businesses can act towards it. E-modules allow students to train critical thinking skills. In the 2nd half of the semester, sustainability challenges on water, energy, mobility, and food are explored in group projects.

Understand the limits and the potential of corporate sustainability for sustainable development

Develop critical thinking skills (argumentation, communication, evaluative judgment) that are useful in the context of corporate sustainability using an innovative writing and peer review method.

Overview of the key concepts of corporate sustainability and topics related to Water, Energy, Mobility, and Food

Be able to recognize and realize opportunities for corporate sustainability in a business environment

Business implications of sustainable development, in particular for the assessment of sustainability performance, strategic change towards sustainability, technological innovations and sustainability, and finance and corporate sustainability.

Critical thinking skills for corporate sustainability.

In-depth case studies of corporate sustainability challenges in the track phase: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze technological innovations for sustainability? How to invest money in a sustainable way?

Presentation slides will be made available on moodle prior to lectures.

Lecture notes

Literature

S. Brusoni

The lecture 363-0389-00L Technology and Innovation Management needs to be taken in order to participate in this module.

Prerequisites / notice

No specific background in economics or management is required.

Technology and Innovation Management (Additional Cases)

Technology and Innovation Management 3 credits 2G S. Brusoni

Abstract

This course focuses on the analysis of innovation as a pervasive process that cut across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.

Objective

This course intends to enable all students to:

- understand the core concepts necessary to analyze how innovation happens
- master the most common methods and tools organizations deploy to innovate
- develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation

Content

This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success are small.

How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.

Lecture notes

Slides will be available on the TIMGROUP website.

Literature

Readings will be available on the TIMGROUP website.

Production and Operations Management

Production and Operations Management 3 credits 2G T. Netland, P. Schönsleben

Abstract

This core course on Production and Operations Management provides the students insights into the basic theories, principles, concepts, and techniques used to design, analyze, and improve the operational capabilities of an organization.

Objective

Students learn why and how operations can be a competitive weapon; how to design, plan, control, and manage production and service processes; how to improve effectiveness and efficiency in operations; how to take advantage of new technological advancements; and how environmental and social concerns affect decisions in global production networks.

Content

The course covers the most fundamental strategic and tactical concepts in production and operations management. The lectures cover: Introduction to POM; Operations strategy; Capacity management; Production planning and control; Production philosophies; Lean management; Performance measurement; Problem solving; Service operations; New technologies in POM; Servitization; Global production; and Triple-bottom line.

Literature


Principles of Microeconomics

Principles of Microeconomics 3 credits 2G M. Filippini

Abstract

The course introduces basic principles, problems and approaches of microeconomics.

Objective

The learning objectives of the course are:

(1) Students must be able to discuss basic principles, problems and approaches in microeconomics. (2) Students can analyse and explain simple economic principles in a market using supply and demand graphs. (3) Students can contrast different market structures and describe firm and consumer behaviour. (4) Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole. (5) Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.

Lecture notes

Lecture notes, exercises and reference material can be downloaded from Moodle.
Literature

The book can also be used for the course ‘Principles of Macroeconomics’ (Sturm)

For students taking only the course ‘Principles of Microeconomics’ there is a shorter version of the same book:

Complementary:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>W+</td>
<td>3</td>
<td>SG</td>
<td>F. Schweitzer, G. Casiragli, V. Nanumyan</td>
</tr>
</tbody>
</table>

Abstract

Finding solutions: what is complexity, problem solving cycle.

Implementing solutions: project management, critical path method, quality control feedback loop.

Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption

Objective

A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics

Content

Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Lecture notes

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.

The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture

Prerequisites / notice

Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

363-0541-02L| Systems Dynamics and Complexity (Additional Cases) | W+ | 1 | Notice for Mechanical Engineering BSc |

Abstract

This module is an addition to the course Systems Dynamics and Complexity. It offers additional study cases to MAVT Bachelor students who enroll in the main course.

Objective

MAVT Bachelor students learn how to develop and analyze more sophisticated systems dynamics models from different areas, e.g. from biology (population dynamics, cooperation), management (inventory modeling, technology adoption and economics (supply and demand, investment and consumption), to name but a few. The goal is to apply analytical and numeric techniques to gain a deeper understanding of the dynamics of complex systems.
1. Modelling path dependence and formation of standards
   - Why do clocks go clockwise? Why do people in most nations drive on the right? Why do nearly all computer keyboards have the QWERTY layout, even though it is more inefficient compared to DVORAK? It turns out that many real-world processes are path dependent, i.e. small random events early in their history determine the ultimate end state, even when all end states are equally likely at the beginning. Students will learn how to model such processes, to understand the feedback mechanisms that lead to path dependence. As a case in point, we will study the ‘war’ between the Betamax and the VHS standards.

2. Optimal migration as promoter of cooperation
   - Mechanisms to promote cooperative behaviour is a vibrant research topic in various fields - economics, evolutionary biology and management science to name but a few. Students will be introduced to one such mechanism - migration. They will develop and analyse a macroscopic model to study how the rate of migration affects the long-term cooperation rate in a population.

3. Information transfer
   - Information flow in a social system (e.g. about the location of resources or appearance of a competitor) is an important component of group living. For example, it is well known that ants can achieve remarkable feats in finding an optimal route to a food patch through pheromone trails. The goal of this study case is to model information transfer in such systems by investigating the dynamics of trail formation in ants. The students will learn that the complexity in navigating to a food source may nevertheless be explained as a simple dynamical system with one control parameter only.

4. Decisions in social societies
   - In many situations individuals have to decide between two or more options. Such decisions often have a profound impact on the system as a whole, especially regarding group cohesion. Group cohesion is preferred, as individuals can benefit from living in groups, yet it may not be the underlying reason behind individual choices. In this case, students will develop and extend a macroscopic model of an animal social system faced with a decision to choose a new home, and identify the conditions which promote group cohesion versus group splitting.

5. Antigenic variation of HIV
   - One of the characteristics of HIV is that a host can be a carrier and a transmitter of the virus without experiencing symptoms for up to 10 years. This case is concerned with finding the mechanism of HIV disease progression. The students will develop a general population-based model for the interaction of an infectious agent with the host immune system. The model is applicable to a variety of infectious agents, ranging from acute lethal infections to chronic illness. Through analysing and simulating the model, the students will understand how the HIV virus interacts with the host and how the mutation rate of the virus is ultimately responsible for this long asymptomatic period.

6. Compartmental models in epidemiology
   - Many diffusive processes in social systems, such as epidemics, can be understood as a result of the interaction between a few groups (compartment) of individuals. The most common example is to divide a population into those who are susceptible (S) to a disease, those who are infected (I), and those who have recovered (R) and are immune, and to model their interactions. These so called SIR models find wide application in studying non-biological diffusive processes, e.g. spread of technological innovations, fads, internet memes etc. In this study case, students will become familiar with the basic components of an SIR model and the conditions under which a disease can cause the outbreak of an epidemic. Students will extend the basic model to investigate more realistic scenarios relevant to e.g. different vaccination strategies.

Lecture notes: Will be provided

363-0565-00L Principles of Macroeconomics
W 3 credits 2V J.E. Sturm

Abstract
This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?

Objective
This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to every-day economic problems.

Content
This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society’s resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

Lecture notes
The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2467) contains announcements, course information and lecture slides.

Literature

We advise you to also buy access to Apila. This internet platform will support you in learning for this course. To save money, you should buy the book together with Apila. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

▶▶▶ Design, Mechanics and Materials

Focus Coordinator: Prof. Kristina Shea

In order to achieve the required 20 credit points for the Focus Specialization Design, Mechanics and Material you are free to choose any of the courses offered within the focus and are encouraged to select among those recommended. If you wish to take one of the Master level courses, you must get approval from the lecturer.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0360-00L</td>
<td>Procedures for the Analysis of Structures</td>
<td>W+</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>G. Kress</td>
</tr>
</tbody>
</table>

Abstract
Basic theories for structure integrity calculations are presented with focus on strength, stability, fatigue and elasto-plastic structural analysis.

Theories and models for one dimensional and planar structures are presented based on energy theorems.

Objective
Basic principles applied in structural mechanics. Introduction to the theories of planar structures. Development of an understanding of the relationship between material properties, structural theories and design criteria.

Inhalt:
1. Basic problem of continuum mechanics and energy principles: structural theories, homogenization theories; finite elements; fracture mechanics.
4. Structural design: fatigue and dynamic structural analysis.
Lecture notes yes

151-0364-00L Light Weight Structures Laboratory W+ 4 credits 5A M. Zogg, P. Ermanni

Abstract
Teams of 2 to 4 students have to design, size, and manufacture a lightweight structure complying with given specifications. A prototype as well as an improved component will be tested and assessed regarding to design and to structural mechanical criteria.

Objective
To develop the skills to identify and solve typical problems of the structure mechanics on a real application. Other important aspects are to foster team work and team spirit, to link theoretical knowledge and practice, to gather practical experiences in various fields related to lightweight structures such as design, different CAE-methods and structural testing.

Content
The task of each team (typically 2-4 students) is the realization of a load-carrying structure with selected materials. The teams are free to develop and implement their own ideas. In this context, specified requirements include information about loads, interfaces to the surrounding structures.

The project is structured as described below:
- Concept development
- design of the component including FEM simulation and stability checks
- manufacturing and structural testing of a prototype
- manufacturing and structural testing of an improved component
- Report

The project work is supported by selected teaching units.

Lecture notes handouts for selected topics are available

151-0509-00L Microscale Acoustofluidics W 4 credits 3G J. Dual

Number of participants limited to 30.

Abstract
In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

Objective
Understanding acoustophoresis, the design of devices and potential applications

Content
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microrobots to surface acoustic wave devices


Literature

Prerequisites / notice
Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

151-0524-00L Continuum Mechanics I W 4 credits 2V+1U E. Mazza

Abstract
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

Objective
Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

Content

Lecture notes yes

151-0532-00L Nonlinear Dynamics and Chaos I W 4 credits 2V+2U G. Haller, F. Kegelbauer

Abstract
Basic facts about nonlinear systems; stability and near-equilibrium dynamics; bifurcations; dynamical systems on the plane; non-autonomous dynamical systems; chaotic dynamics.

Objective
This course is intended for Masters and Ph.D. students in engineering sciences, physics and applied mathematics who are interested in the behavior of nonlinear dynamical systems. It offers an introduction to the qualitative study of nonlinear physical phenomena modeled by differential equations or discrete maps. We discuss applications in classical mechanics, electrical engineering, fluid mechanics, and biology. A more advanced Part II of this class is offered every other year.

Content
(1) Basic facts about nonlinear systems: Existence, uniqueness, and dependence on initial data.

(2) Near equilibrium dynamics: Linear and Lyapunov stability

(3) Bifurcations of equilibria: Center manifolds, normal forms, and elementary bifurcations

(4) Nonlinear dynamical systems on the plane: Phase plane techniques, limit sets, and limit cycles.

(5) Time-dependent dynamical systems: Floquet theory, Poincare maps, averaging methods, resonance

Lecture notes The class lecture notes will be posted electronically after each lecture. Students should not rely on these but prepare their own notes during the lecture.

Prerequisites / notice
- Prerequisites: Analysis, linear algebra and a basic course in differential equations.
- Exam: two-hour written exam in English.
- Homework: A homework assignment will be due roughly every other week. Hints to solutions will be posted after the homework due dates.

151-0731-00L Forming Technology I - Basic Knowledge W 4 credits 2V+2U P. Hora

Abstract
The fundamentals of forming technology are presented to Mechanical, Production and Material Engineers. The content of the lecture is:
Overview of manufacturing with forming techniques, deformation specific description of material properties and their experimental measurement, material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure.

Objective
Forming technology represents with its 70% global share in manufactured metal volume with respect to yield and cost, the most important manufacturing process in metal-working industries. Typical applications of forming technology range from the manufacturing of sheet metal components in auto bodies to applications in food and pharma packaging, fabrication of implants in medical technologies and to the fabrication of leads in microelectronic components. This course introduces the fundamentals which are essential to evaluate metal-forming processes and their industrial applications. This includes, together with the acquirements of the most important forming processes, the characterization of plastic material behavior and manufacturing limits.

Content
Overview of the most important processes of metal-forming technology and its field of applications, characterization of the plastic metal-forming behavior, basic principles of plasto-mechanical calculations, metal-forming residual stresses, thermo-mechanical coupling of metal-forming processes, influence of tribology, Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery.

Lecture notes ja

151-0735-00L Dynamic Behavior of Materials and Structures W 4 credits 2V+2U D. Mohr

Data: 06.11.2018 12:57
Autumn Semester 2016
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Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme loadings during manufacturing, crash, impact and blast events.

Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering.

Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;

Slides of the lectures, relevant journal papers and user manuals will be provided.

Various books will be recommended covering the topics discussed in class

Course in continuum mechanics (mandatory), finite element method (recommended)

Studies on Engineering Design
W+ 3 credits 6A K. Shea, P. Ermanni, M. Meboldt

Abstract
This course introduces students to the exciting world of Engineering Design research, which crosses disciplines and requires a variety of skills. Each student identifies a topic in Engineering Design for further investigation, either based on those proposed or a new, agreed topic.

Objective
Students gain their first knowledge of Engineering Design research and carry out their first, independent scientific study. Students learn how to read scientific literature and critically analyze and discuss them, gain hands-on experience in the area and learn how to document their work concisely through a report and short presentation.

Content
Students identify 5-10 journal articles, or scientifically equivalent, in consultation with the supervisor and can define a small, related project in the area to gain hands-on experience. In the beginning of the semester, students develop with the supervisor a 2-page proposal outlining the objective of the study, tasks to be carried out and a brief time plan for the work. Once agreed, the project starts resulting in a report combining the state-of-art literature review and project results, if carried out.

The students work independently on a study of selected topics in the field of Engineering Design. They start with a selection of the topic, identify scientific papers for the literature research and can define a small, related project. The results (e.g. state-of-the-art literature review and small project results where defined) are evaluated with respect to predefined criteria.

Prerequisites / notice
Students take this course in parallel to the Lecture "Grand Challenges in Engineering Design". A general meeting will be held in the beginning of the semester to propose topics for the studies. Studies are carried out individually and can be the pre-study for a Bachelor thesis.

Grand Challenges in Engineering Design
W+ 1 credit 3S P. Ermanni, M. Meboldt, K. Shea

Abstract
The course is structured in three main blocks, each of them addressing a specific grand challenge in engineering design. Each block is composed of an introductory lecture and two to three invited talks, considering a good mix between speakers coming from academia and industry. Each talk is introduced and moderated by the students.

Objective
The aim of the course is to introduce students to the engineering design research and practice in a multitude of Mechanical Engineering disciplines and convey knowledge from both academia and industry about state of the art methods, tools and processes.

Content
The students are exposed to a variety of topics in the field of Engineering Design. Topics are bundled in three main grand challenges and include an introductory lecture held by one of the responsible Professors and 2-3 invited talks of 45 min. each, addressing specific issues. The success of the course is largely dependant on active involvement of the students. Accordingly, a small group of students (1-3) is asked to introduce and moderate each external talk. The group will therefore gather adequate information about the speaker and topic, read and synthesize relevant documents and scientific papers, prepare questions to motivate the interaction with the audience and summarize, at the end of the lecture, the discussed points and outcome.

Prerequisites / notice
Offered in English and German

Lightweight
W+ 4 credits 4G P. Ermanni

Abstract
The elective course Lightweight includes numerical methods for the analysis of the load carrying and failure behavior of lightweight structures, as well as construction methods and design principles for lightweight design.

Objective
The aim of the course is to introduce students to the engineering design research and practice in a multitude of Mechanical Engineering disciplines and convey knowledge from both academia and industry about state of the art methods, tools and processes.

Content
Lightweight design
Thin-walled beams and structures
Instability behavior of thin walled structures
Reinforced shell structures
Load introduction in lightweight structures

Lecture notes
Script, Handouts, Exercises

Engineering Design Optimization
W 4 credits 4G K. Shea, T. Stankovic

Abstract
The course covers fundamentals of computational optimization methods in the context of engineering design. It develops skills to formally state and model engineering design tasks as optimization problems and select appropriate methods to solve them.

Objective
The lecture and exercises teach the fundamentals of optimization methods in the context of engineering design. After taking the course students will be able to express engineering design problems as formal optimization problems. Students will also be able to select and apply a suitable optimization method given the nature of the optimization model. They will understand the links between optimization and engineering design in order to design more efficient and performance optimized technical products. The exercises are MATLAB based.

Content
1. Optimization modeling and theory
2. Unconstrained optimization methods
3. Constrained optimization methods - linear and non-linear
4. Direct search methods
5. Stochastic and evolutionary search methods
6. Multi-objective optimization

Lecture notes available on Moodle

Metals I
W 3 credits 2V+1U R. Spolenak

Abstract
Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

Objective
Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.
### Content

**Dislocation theory:**
- Properties of dislocations, motion and kinetics of dislocations, dislocation-dislocation and dislocation-boundary interactions, consequences of partial dislocations, sessile dislocations

**Hardening theory:**
- a. solid solution hardening: case studies in copper-nickel and iron-carbon alloys
- b. particle hardening: case studies on aluminium-copper alloys

**High temperature plasticity:**
- thermally activated glide
- power-law creep
- diffusional creep: Coble, Nabarro-Herring
- deformation mechanism maps
- Case studies in turbine blades
- superplasticy
- alloying effects

### Literature

- Gottstein, Physikalische Grundlagen der Materialkunde, Springer Verlag
- Haasen, Physikalische Metallkunde, Springer Verlag
- Rösler/Harders/Bäker, Mechanisches Verhalten der Werkstoffe, Teubner Verlag
- Porter/Easterling, Transformations in Metals and Alloys, Chapman & Hall
- Hull/Bacon, Introduction to Dislocations, Butterworth & Heinemann
- Courtney, Mechanical Behaviour of Materials, McGraw-Hill

### 327-1204-00L Materials at Work I

**W 4 credits 4S**

**R. Spolenak, E. Dufresne, R. Koopmans**

#### Abstract

This course attempts to prepare the student for a job as a materials engineer in industry. The gap between fundamental materials science and the materials engineering of products should be bridged. The focus lies on the practical application of fundamental knowledge allowing the students to experience application related materials concepts with a strong emphasis on case-study mediated learning.

#### Objective

**Teaching goals:**
- to learn how materials are selected for a specific application
- to understand how materials around us are produced and manufactured
- to understand the value chain from raw material to application
- to be exposed to state of the art technologies for processing, joining and shaping
- to be exposed to industry related materials issues and the corresponding language (terminology) and skills
- to create an impression of how a job in industry "works", to improve the perception of the demands of a job in industry

#### Content

This course is designed as a two semester class and the topics reflect the contents covered in both semesters.

Lectures and case studies encompass the following topics:

- Strategic Materials (where do raw materials come from, who owns them, who owns the IP and can they be substituted)
- Materials Selection (what is the optimal material (class) for a specific application)
- Materials systems (subdivisions include all classical materials classes)
  - Processing
  - Joining (assembly)
  - Shaping
- Materials and process scaling (from nm to m and vice versa, from mg to tons)
- Sustainable materials manufacturing (cradle to cradle) Recycling (Energy recovery)

After a general part of materials selection, critical materials and materials and design four parts consisting of polymers, metals, ceramics and coatings will be addressed.

In the fall semester the focus is on the general part, polymers and alloy case studies in metals. The course is accompanied by hands-on analysis projects on everyday materials.

#### Literature

- Manufacturing, Engineering & Technology
  - Serope Kalpakjian, Steven Schmid
  - ISBN: 978-0131489653

**Prerequisites / notice**

Profound knowledge in Physical Metallurgy and Polymer Basics and Polymer Technology required (These subjects are covered at the Bachelor Level by the following lectures: Metalle 1, 2; Polymere 1,2)

### Engineering Tools IV

The participation at the Engineering Tools course is mandatory. If you miss any classes, no credit points will be awarded. For exemptions you have to contact the lecturer of the course.

#### Number

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0015-10L Engineering Tool IV: Experimental Modal Analysis</td>
<td>W</td>
<td>0.4 credits</td>
<td>1K</td>
<td>F. Kuster, K. Wegener</td>
</tr>
</tbody>
</table>

**Number of participants limited to 16.**

**Only one course can be chosen per semester.**

#### Abstract

Measuring- and analysis-methods for the determination of transfer functions of mechanical structures. Evaluation and preparation of the measured data for visualisation and interpretation of the dynamic behaviour.

#### Objective

Introduction into the practical application of measuring- and analysis-methods for determination of transfer functions of mechanical structures. Evaluation and preparation of the measured data for visualisation and interpretation of the dynamic behaviour.

#### Content

Acquaintance with the acceleration- and force-sensors, measurement of transfer functions of mechanical structures, determination and description of modes of vibration by means of practical examples, introduction into the vibration theory and its fundamental terms, discrete oscillator.

#### Lecture notes

yes, distribution in the course (CHF 20.-)

#### Literature

David Ewins, Modal Testing: Theory and Practice

#### Prerequisites / notice

In the practical part of the course the participants will make measurements on structures and then analyse them for eigenfrequencies and modes of vibrations.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lecturer(s)</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0017-10L</td>
<td>Engineering Tool IV: Introduction to Structural Testing</td>
<td>0.4</td>
<td>P. Ermanni</td>
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<tr>
<td></td>
<td>All Engineering Tool courses are for MAVT-Bachelor students only.</td>
<td></td>
<td></td>
<td>Eligible to students of Focus Specialization &quot;Structure Mechanics&quot;.</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 18.</td>
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<td>Only one course can be chosen per semester.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Structural testing is a very broad and interdisciplinary field. Taking into account the limited time, the scope of this tool-course is to provide a general introduction to structural testing, with particular attention to theoretical and practical aspects of strain gage measurements. Furthermore a real engineering case is presented and discussed in small groups.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>Introduction to structural testing. Focus lies in measurements with strain gages. Selected case-studies help the participant to better understanding critical issues and possible solutions.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<td></td>
<td>Working with strain gages preparation of the structure, positioning and application of the strain gages, data-gathering, verification.</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
<td></td>
<td></td>
<td><strong>Content</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Literature</strong></td>
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<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
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<tr>
<td>151-0024-10L</td>
<td>Engineering Tool IV/V: Digital Automotive Plant Simulation Methods</td>
<td>0.4</td>
<td>P. Hora</td>
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<td></td>
<td>All Engineering Tool courses are for MAVT-Bachelor students only.</td>
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<td></td>
<td>Number of participants limited to 25.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Application of the special-purpose simulation and planning tool AUTOFORM for the digital modelling of manufacturing processes in sheet metal forming (car panels production). Introduction to virtual methods. Demonstration of industrial examples.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
<td></td>
<td></td>
<td>Modern FEM tools for virtual modeling of forming processes. The course provides following concepts:</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
<td></td>
<td></td>
<td>- Fundamentals of non linear Finite-Element-Methods (FEM)</td>
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<tr>
<td></td>
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<td>- The development of the virtual model</td>
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<td>- Material properties</td>
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<td>- Tool and contact conditions</td>
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<td>- Process evolution</td>
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<td>- Introduction to AUTOFORM software</td>
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<td>- Independent simulation exercises</td>
</tr>
<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
<td></td>
<td></td>
<td>Course documentation</td>
</tr>
<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
<td></td>
<td></td>
<td>maximal number of participants: 25</td>
</tr>
<tr>
<td>151-0025-10L</td>
<td>Engineering Tool IV: Introduction to CAM and Motion Simulation</td>
<td>0.4</td>
<td>M. Schmid, K. Wegener</td>
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<td></td>
<td>All Engineering Tool courses are for MAVT-Bachelor students only.</td>
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<td>Number of participants limited to 40.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Introduction of integrated CAD applications CAM (Computer Aided Manufacturing), Motion Simulation (Kinematics)</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
<td></td>
<td></td>
<td>The participants learn the possibilities of integrated CAD applications. The goal is to understand the procedures and the most important functions of these applications.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<td>CAM: Introduction to CAM, practical examples for a 3-axis milling machine</td>
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<td></td>
<td><strong>Prerequisites / notice</strong></td>
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<td>Voraussetzungen:</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>- CAD-Grundkenntnisse in NX (CAD 1. Sem.)</td>
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<td></td>
<td>- Eigener Laptop mit installierter, lauffähiger Software NX für die Durchführung der Übungen (Siemens NX kann über Stud-IDES kostenlos bestellt werden).</td>
</tr>
<tr>
<td>151-0027-10L</td>
<td>Engineering Tool IV/V: Programming with LabView</td>
<td>0.4</td>
<td>L. Prochazka, T. Rösgen</td>
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<tr>
<td></td>
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<td>Number of participants limited to 16.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Only one course can be chosen per semester.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>An introduction is given to the LabView programming environment. The basic concepts of &quot;virtual instruments&quot; and data flow programming are presented. Computer-based exercises are solved during class. A simple electronic data acquisition module is used to demonstrate basic concepts of interface management and data acquisition.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<td></td>
<td>Introduction to the LabView programming environment. Understanding of fundamental concepts: virtual instruments, data flow programming, control structures, data types etc.</td>
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<td>Development of basic programming skills using in-class exercises on computers.</td>
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<tr>
<td>151-0030-10L</td>
<td>Engineering Tool IV: Modelling and Servo Axis Control of Machine Tool Manipulators</td>
<td>0.4</td>
<td>O. Zirn, K. Wegener</td>
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<tr>
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<td>Number of participants limited to 16.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
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<td><strong>Objective</strong></td>
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<td>An introduction is given to the LabView programming environment. The basic concepts of &quot;virtual instruments&quot; and data flow programming are presented. Computer-based exercises are solved during class. A simple electronic data acquisition module is used to demonstrate basic concepts of interface management and data acquisition.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
<td></td>
<td></td>
<td>Introduction to the LabView programming environment. Understanding of fundamental concepts: virtual instruments, data flow programming, control structures, data types etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Development of basic programming skills using in-class exercises on computers.</td>
</tr>
</tbody>
</table>
Prerequisites: Matlab skills; your laptop with Matlab/Simulink may be useful.

Number of participants limited to 30.

Only one course can be chosen per semester.

Abstract
This course covers model building and the applied stimulation of (power-assisted axles on production machinery using MATLAB/Simulink and provides a practical example of how drive parameters may be set up, how through simulation an optimal axis design can be developed and which characteristics of a production machine can be reliably estimated in advance.

Objective
The students are able to model servo axes considering all relevant components and process influences to simulate the achievable productivity.

Content
1. Introduction, complexity levels in model building for production machines.
2. Complexity level 1: Power-assisted axles, transmission systems, general structural model.
3. Complexity level 2: Robotic models, kinematics and dynamics
4. Complexity level 3: Multi-body models and finite element models
5. Regulation of power-assisted axles, cascade regulator and state regulator extensions.
7. Master slave and gantry operations with dispersed servo drive.
8. Simulation examples in MATLAB/Simulink ((Swivel axle, 5-axle milling machine, parallel kinematic milling machine, industrial robots).

Lecture notes
Prerequisite is knowledge of Matlab.

Prerequisites / notice
151-0032-10L Engineering Tool IV: Introduction to the Methods of Six Sigma Quality Control and Lean Production
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 36.

Only one course can be chosen per semester.

Abstract
The course introduces to Six Sigma quality management and quality improvement, which aims to reduce process variation and to sustain process capability. It introduces also to the Lean production principles, aiming to reduce waste within the processes as well as aiming to a customer taked pull-production.

Objective
The participant gets an overview to the Operational Excellence philosophy and the working methods of these two approaches. He learns the most important tools and the interaction of these two approaches.

Content
1. Understanding the changing environment
   - Globalization, customer requirements, production systems
   - Six Sigma quality philosophy
   - Lean Manufacturing and TPS (Toyota Production System)
2. Quality management with Six Sigma
   - What is Six Sigma
   - DMAIC problem solving cycle
   - Use of different control charts
   - Evaluate process capability, DPMO, Cp, Cpk, Taguchi
   - Cause-effect diagram
   - Control plan and sustainability, PDCA
3. Introduction to the Lean approach
   - Lean goals and principles
   - A3 project management
   - The 9 types of waste
   - Value add and non value add activities
   - The 8 Lean-Tools, whereof 4
   - 5S workplace organization
   - Value stream mapping (excercise), Little's law
   - Continuous flow vs batch
   - Pull Principles, Kanban, DBR
   - Cell design
   - Linear Programming
4. Lean and Six Sigma in practice
   - How ils Lean and Six Sigma together
   - Continuous Improvement/Kaizen organization
   - Change-Management, risks
   - Inspire deployment approach

Lecture notes
Notes will be distributet.

151-0044-10L Engineering Tool IV/V: Computational Fluid Dynamics (CFD) with OpenFoam
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 40.

Only one course can be chosen per semester.

Abstract
Participants will learn to use the open source simulation software OpenFOAM on a user level (i.e. to conduct classical CFD studies). We will also introduce the students into programming with OpenFOAM so they will be able to implement additional equations into existing solvers.

Objective
Participants will learn to use the open source simulation software OpenFOAM on a user level (i.e. to conduct classical CFD studies). We will also introduce the students into programming with OpenFOAM so they will be able to implement additional equations into existing solvers.
Content
OpenFOAM is a very professional open-source simulation package which is freely (CHF 0.-) available under the GNU General Public License (GPL). It consists of a vast C++ library, many different applications and additional tools. Although most of the existing applications are flow solvers, OpenFOAM can be used in many different areas, as varied as solid dynamics, electromagnetics or pricing of financial options.

Most users make only use of the included applications. One particular strength of OpenFOAM, however, is that new applications and even extensions of the library can be developed in a rather compact and elegant way.

Prerequisites / notice
Knowing C++ or at least having some experience in another programming language will be of an advantage but is not strictly required to follow this course.

151-0057-10L Engineering Tool IV/V: Systems Engineering for Project Work
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 60.

Abstract
The course is about a methodical basis of systematic project work, with a focus on demanding interdisciplinary problems. The participants will be shown how to use it appropriately and correctly in their projects. This short course is based on the “Systems Engineering” (SE) method, which was developed at the ETH.

Objective
The goals of this compact course are:
- Goal-oriented identification and perception of relevant problem areas and project goal setting.
- Deduction and development of procedures for a promising project, including systematic planning of the project content.
- Development of work packages including efficient methodology
- Simple embedding of the projects in the organization, including relationships with buyers, users and securing project participation.

Content
1. Nachmittag:
- Einstieg ins Systems Engineering; Entstehung, Inhalt und Werdegang; Voraussetzungen (anspruchsvolle Fragestellungen, institutionelle Einbettung, Systemdenken und heuristische Prinzipien);
- Grundstruktur und Inhalt Lebensphasenmodell; Grundstruktur in Inhalt Problemlösungszyklus;
- Zusammenspiel von Lebensphasenmodell & Problemlösungszyklus in Projekten
2. Nachmittag:
- Situationsanalyse: Systemanalyse (Systemabgrenzung (gestaltbarer Bereich, relevante Bereiche des Umkreises, Methoden der Analyse und Modellierung, Umgang mit Vernetzung, Dynamik und Unsicherheit; wichtigste Methoden der IST-Zustands- und Zukunftsanalyse),
- Zielformulierung (wichtigste Methoden der Zielformulieren),
- Konzeptheorie und Konzeptanalyse (u.a. Kreativität; wichtigste Methoden der Synthese und Analyse),
3. Nachmittag:
- Beurteilung (u.a. Methoden für mehrdimensionale Kriterienvergleich, z.B. Kosten-Wirksamkeits-Analyse); Diskussion von Planungsbeispielen
- Diskussion von Planungsbeispielen: Analyse des Methodeneinsatzes, Entwickeln alternativer Vorgehensschritte und Auswahl des zweckmässigsten Vorgehens

Lecture notes
Zusammenfassung wird in elektronischer Form abgegeben;
Lehrbuch: die Grundlagen sind in einem Lehrbuch beschrieben
Anwendungsbeispiele: 8 konkrete Anwendungen von Systems Engineering sind in einem Case-Book beschrieben

Prerequisites / notice
Zielpublikum: Der Kurs richtet sich insbesondere an Personen, welche anspruchsvolle Projekte initiieren, planen und leiten müssen
Lernmethode: Der Stoff wird mittels kurzer Vorträge vermittelt und an kurzen Fallbeispielen/Übungen vertieft. Zudem sollen die Lehrinhalte durch selbstständiges Studium der Lehrmittel vertieft bzw. ergänzt werden.

151-0059-10L Engineering Tool IV: CAD-Methodology and PDM-Technology in the Focus Project
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 25.

Abstract
The participants learn about the procedures and tools that are necessary to develop technical products. The focus is on computer-based design and development and the management in an integrated software environment.

Objective
The participants will deepen their existing CAD knowledge and learn new PDM knowledge, so that these may be directly applied and used in the focus project.
- CAD refresh (Modelling, Assembling, Drafting, etc.) and CAD mythology for construction (Top-Down modelling)
- Introduction to the Team Center (Siemens PDM System)
- TeamCenter data flow, in particular the process of creating and managing new Items and Parts, the approval procedure and creating different versions of Parts

The participants will learn and experiment with procedures by working on concrete examples so that they will subsequently be able to begin with independent product construction.

The following topics will be dealt with in depth in the lectures supporting the focus project (Praxiskurs): CAD-Methodology, FE calculations, motion simulation and construction methodology.
1. Afternoon: CAD refresher and top down modelling
   - To refresh already existing knowledge of CAD functionality.
   i. Sketch and features as well as manipulation and optimizing models.
   ii. Assembling
   iii. Drafting.
   iv. Organisation, working methods, conventions.
   - Top down modelling CAD
   i. Introduction to top down modelling and concept modelling
   ii. Case study of top down modelling

2. Afternoon: Introduction to TC (Team Center)
   - Introduction: Short introduction to PLM (What is the idea of PLM? PLM is more than the pure management of drawings!).
   - Lesson 1 - Team Center Rich Client Interface
   - Lesson 2 - TC data types
   - Lesson 3 - Construction from data in TC
   - Lesson 4 - Searching for and examining data.

3. Afternoon: TC application
   - Lesson 5 - Unit lists (PSE)
   - Lesson 6 - Cross-referencing
   - Lesson 7 - Data release
   - Lesson 8 - Product data examination

Prerequisites / notice
- at least two students of a Focus-Team should sign in for this course, if the use of Siemens TeamCenter PLM is given for the Team.
- only for students participating in a Focus Project in the same semester
- not more than 25 students
Basics in: Perspective, line drawing, proportions, implementation of the plan views of perspective

Lecture notes
It requires no further books

Literature
Max 20 participants
Material: Paper and pens

151-0091-10L  Engineering Tool IV: Scientific Writing  W  0.4 credits  1K  U. Brändle, M. Paschke
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 50.

Abstract
Participants acquire scientific writing basics as a core competency to communicate with different audiences. They apply important methods and tools to refine a scientific question, research and evaluate the necessary information, quote and paraphrase, and to plan the structure of their own text.

Objective
Students are able to:
- derive and structure ideas for a text starting from a scientific question using simple techniques
- find literature sources, check their relevance and completeness, organize them with a suitable tool and cite correctly
- apply a reading technique for summarizing a text
- distinguish plagiarism, quotation and paraphrase in texts using the presented criteria and correctly cite or paraphrase external content
- use and cite information from the Internet correctly
- plan and structure specialized texts that refer to different target groups

Content
KURSPROGRAMM
1. Halbtag: Recherchieren und Lesen
   (1) Auf Vorhandenem aufbauen
   (2) Ideen generieren
   (3) Recherchieren
   (4) Quellen beurteilen

2. Halbtag: Paraphrasieren nicht Plagiarisieren
   (1) Verantwortlich sein: der Wert des eigenständigen Denkens
   (2) Regeln und Anweisungen: was ist ein Plagiat, wie wird es an der ETHZ gehandhabt, Eigenständigkeitserklärung, Prüfwerkzeuge
   (3) Zitieren und Paraphrasieren - so geht's
   (4) Paraphrasieren oder Zitieren?
   (5) Lesen und verstehen
   (6) Vom Umgang mit Quellen und Material aus dem Internet

3. Halbtag: Einen Text strukturieren und generieren
   (1) Verwendung einer Standard-Textstruktur als Vorlage für ein Outline
   (2) Ein Grundgerüst mit Abschnitten erstellen
   (3) Eine Textabschnitt schreiben

LEHRFORMEN
- Inputs: Kurzvorträge
- Übungen: während des Nachmittags selbständig in Moodle anhand von Fallstudien
- Feedback und Diskussion: Lösungen der Studierenden via Moodle zu Dozentenbeamer und Besprechen durch die Dozierenden

Literature

Prerequisites / notice
Computer für Online-Übungen während der Veranstaltung.

Workshop Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0003-00L</td>
<td>Workshop Training</td>
<td>O</td>
<td>5 credits</td>
<td>4P</td>
<td>external organisers</td>
</tr>
</tbody>
</table>

Abstract
Students are required to conduct a workshop training outside ETH Zurich for a minimum duration of five weeks. The students learn how to operate workshop equipment, and acquire first experience in the realization of an engineering project. They summarize the workshop practice in a work and project description.

Objective
The students learn how to operate workshop equipment, and acquire first experience in the realization of an engineering project.

Laboratory Practice

Students attend at least 10 Laboratory Practices during the 4th and 5th semester. 4 of these must be Physics laboratories. All laboratory work is graded "pass" or "fail". After completion of 10 laboratory training units, 2 credit points will be issued.

Please register online at www.mavt.ethz.ch/praktika

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0029-10L</td>
<td>Laboratory Practice</td>
<td>O</td>
<td>2 credits</td>
<td>4P</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
Selected laboratory experiments in physics, mechanical and process engineering. With the Laboratory Training held during the fourth and fifth semester, the students learn how to handle and apply measurement methods and devices. Students are offered a diversified choice of laboratory experiments at least ten of which must be completed. Four of the chosen experiments must be in physics.

Objective
With the Laboratory Training held during the fourth and fifth semester, the students learn how to handle and apply measurement methods and devices.

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-MAVT.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH
Bachelor's Thesis

The Bachelor's Thesis can be only started when the First Year Examinations, the Additional First Year Courses, the Examination Block 1 and 2 are passed. It is insistently recommended for students to only begin the Bachelor's Thesis if 150 credit points have been achieved. The thesis corresponds to a work load of 420 hours and can be done in part- or full-time.

The declaration of originality is an integral part of the Bachelor's Thesis.

Potential supervisors for the Bachelor's Thesis:
- All D-MAVT professors (https://www.mavt.ethz.ch/the-department/people/professors.html)
- Professors in other departments who are accredited at D-MAVT (https://www.mavt.ethz.ch/the-department/people/accredited-professors.html)
- D-MAVT titular professors (https://www.mavt.ethz.ch/the-department/people/titular-professors.html). For enrollment, please contact the D-MAVT Student Administration.

Abstract
The bachelor's thesis is the culmination of the program. The students develop, enhance, and demonstrate their methodological abilities to independently tackle and solve a given research problem. The thesis furnishes the students with their first major research experience and is a further development of the work done in the basis courses, and usually, the focused study.

Objective
The students develop, enhance and demonstrate their methodological abilities to independently tackle and solve a given research problem.

Content
The topics for the bachelor's thesis are published by the professorship or they can be set in consultation between the professors and the students. Thesis projects in cooperation with the industry are also possible.

Prerequisites / notice
Supervisors should normally be part of the D-MAVT professorship or may be professors accredited by D-MAVT.

Bachelor's Thesis (Focus Spezialization Management, Technology and Economics)

Potential supervisors for the thesis MTEC is the Focus Spezialization Management, Technology and Economics.

Abstract
The bachelor's thesis is the culmination of the program. The students develop, enhance and demonstrate their methodological abilities to independently tackle and solve a given research problem. The thesis furnishes the students with their first major research experience and is a further development of the knowledge acquired in the engineering fundamentals and the focused study.

Objective
The students develop, enhance and demonstrate their methodological abilities to independently tackle and solve a given research problem.

Content
The topics for the bachelor's thesis are defined by the professorship or can be set in consultation between the professors and the students.

Prerequisites / notice
Exclusively D-MAVT students who have enrolled for the focus specialization Management, Technology and Economy are eligible for this type of bachelor's thesis. Supervisors are normally part of the D-MTEC professorship. Further prerequisites have to be discussed with the responsible professor. The bachelor's thesis must be completed within 14 weeks which is an equivalent half-time workload during a semester.

Mechanical Engineering Bachelor - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Mechanical Engineering Master

Core Courses

Energy, Flows and Processes

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>P. Koumoutsakos</td>
</tr>
</tbody>
</table>

Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multi-core architectures.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0105-00L</td>
<td>Quantitative Flow Visualization</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>T. Rösgen</td>
</tr>
</tbody>
</table>

Abstract
The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.

Objective
Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization. Understanding of hardware and software requirements and solutions.

Content
Development of basic programming skills for (generic) imaging applications.

Lecture notes
available

Prerequisites / notice
Prerequisites: Fluidodynamics I, Numerical Mathematics, programming skills.
Language: German on request.

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0107-20L</td>
<td>High Performance Computing for Science and Engineering (HPCSE) I</td>
<td>W</td>
<td>4 credits</td>
<td>4G</td>
<td>M. Troyer, P. Chatzidoukas</td>
</tr>
</tbody>
</table>

Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

<table>
<thead>
<tr>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0109-00L</td>
<td>Turbulent Flows</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>P. Jenny</td>
</tr>
</tbody>
</table>

Abstract
- Laminar and turbulent flows, instability and origin of turbulence
- Statistical description: averaging, turbulent energy, dissipation, closure problem
- scalings. Homogeneous isotropic turbulence, correlations, fourier representation, energy spectrum
- Free turbulence: wake, jet, mixing layer
- Wall turbulence: Channel and boundary layer
- Computation and modelling of turbulent flows

Objective
Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation and elements of turbulence modelling

Content
- Properties of laminar, transitional and turbulent flows.
- Origin and control of turbulence. Instability and transition.
- Statistical description, averaging, equations for mean and fluctuating quantities, closure problem.
- scalings, homogeneous isotropic turbulence, energy spectrum.
- Turbulent free shear flows. Jet, wake, mixing layer.
- Wall-bounded turbulent flows.
- Turbulent flow computation and modeling.

Lecture notes
Lecture notes are available

Literature
151-0113-00L

Applied Fluid Dynamics

W 4 credits 2V+1U J.P. Kunsch

Abstract

Applied Fluid Dynamics

The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment.

Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).

Objective

Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples.

Content

Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water.

There are many possible forms that the resulting damage may take, including fire resulting from explosion when flammable substances are mixed. The topics covered include: Emissions of liquids and gases from containers and pipelines, evaporation from pools and vaporization of gases kept under pressure, the spread and dilution of waste gas plumes in the wind, deflagration and detonation of inflammable gases, fireballs in gases held under pressure, pollution and exhaust gases in tunnels (tunnel fires etc.)

Lecture notes

not available

Prerequisites / notice

Requirements: successful attendance at lectures "Fluidodynamik I und II", "Thermodynamik I und II"

151-0163-00L

Nuclear Energy Conversion

W 4 credits 2V+1U H.M. Prasser

Abstract

Physical fundamentals of the fission reaction and the sustainable chain reaction, thermal design, construction, function and operation of nuclear reactors and power plants, light water reactors and other reactor types, conversion and breeding

Objective

Students get an overview on energy conversion in nuclear power plants, on construction and function of the most important types of nuclear reactors with special emphasis to light water reactors. They obtain the mathematical/physical basis for quantitative assessments concerning most relevant aspects of design, dynamic behaviour as well as material and energy flows.

Content

Nuclear physics of fission and chain reaction. Thermodynamics of nuclear reactors. Design of the reactor core. Introduction into the dynamic behaviour of nuclear reactors. Overview on types of nuclear reactors, difference between thermal reactors and fast breeders. Construction and operation of nuclear power plants with pressurized and boiling water reactors, role and function of the most important safety systems, special features of the energy conversion. Development tendencies of reactor technology.

Lecture notes

Hand-outs will be distributed. Additional literature and information on the website of the lab: https://www.ethz.ch/content/specialinterest/maxv/energy-technology/lab-of-nuclear-energy-systems/en/studium/teaching-materials/151-0163-00l-nuclear-energy-conversion.html

Literature


R. L. Murray: Nuclear Energy (Sixth Edition), An Introduction to the Concepts, Systems, and Applications of Nuclear Processes, Elsevier

151-0182-00L

Fundamentals of CFD Methods

W 4 credits 3G A. Haselbacher

Abstract

This course is focused on providing students with the knowledge and understanding required to develop simple computational fluid dynamics (CFD) codes to solve the incompressible Navier-Stokes equations and to critically assess the results produced by CFD codes.

As part of the course, students will write their own codes and verify and validate them systematically.

Objective

1. Students know and understand basic numerical methods used in CFD in terms of accuracy and stability.
2. Students have a basic understanding of typical CFD codes.
3. Students understand how to assess the numerical and physical accuracy of CFD results.

Content

1. Governing and model equations. Brief review of equations and properties
2. Overview of basic concepts: Overview of discretization process and its consequences
3. Overview of numerical methods: Finite-difference and finite-volume methods
4. Analysis of spatially discrete equations: Consistency, accuracy, stability, convergence of semi-discrete methods
5. Time-integration methods: LMS and RK methods, consistency, accuracy, stability, convergence
6. Analysis of fully discrete equations: Consistency, accuracy, stability, convergence of fully discrete methods
7. Solution of one-dimensional advection equation: Motivation for and consequences of upwinding, Godunov’s theorem, TVD methods, DRP methods
8. Solution of two-dimensional advection equation: Dimension-by-dimension methods, dimensional splitting, multidimensional methods
9. Solution of one- and two-dimensional diffusion equations: Implicit methods, ADI methods
10. Solution of one-dimensional advection-diffusion equations: Numerical vs physical viscosity, boundary layers, non-uniform grids
11. Solution of incompressible Navier-Stokes equations: Incompressibility constraint and consequences, fractional-step and pressure-correction methods
12. Solution of incompressible Navier-Stokes equations on unstructured grids

Lecture notes

The course is based mostly on notes developed by the instructor.

Literature

There is no required textbook. Suggested references are:
3. Prior knowledge of fluid dynamics, applied mathematics, basic numerical methods, and programming in Fortran and/or C++ (knowledge of MATLAB is “not” sufficient).

151-0185-00L

Radiation Heat Transfer

W 4 credits 2V+1U A. Steinfeld, A. Z'Graggen

Abstract

Advanced course in radiation heat transfer

Objective

Fundamentals of radiative heat transfer and its applications. Examples are combustion and solar thermal/thermochemical processes, and other applications in the field of energy conversion and material processing.

Content


Lecture notes

Copy of the slides presented.

Literature


151-0203-00L

Turbomachinery Design

W 4 credits 2V+1U R. S. Abhari, N. Chokani, B. Ribi

Abstract

Applied Fluid Dynamics

The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment.

Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).

Objective

Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples.

Content

Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water.

There are many possible forms that the resulting damage may take, including fire resulting from explosion when flammable substances are mixed. The topics covered include: Emissions of liquids and gases from containers and pipelines, evaporation from pools and vaporization of gases kept under pressure, the spread and dilution of waste gas plumes in the wind, deflagration and detonation of inflammable gases, fireballs in gases held under pressure, pollution and exhaust gases in tunnels (tunnel fires etc.)

Lecture notes

not available

Prerequisites / notice

Requirements: successful attendance at lectures "Fluidodynamik I und II", "Thermodynamik I und II"
Introduction to the understanding of a broad range of turbomachinery devices. Learn the steps of turbomachinery design.

Lecture notes

The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics. The course first reviews the governing equations and combustion chemistry, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic combustion and its coupling with homogeneous combustion are deal in detail, and turbulent combustion modeling approaches are presented. Available numerical codes will be used for modeling.

Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.

During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on.

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microflows among others.

Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.

The content of the course includes:

1. Background: Elements of statistical mechanics and kinetic theory:
   Particle's distribution function, Liouville equation, entropy, ensembles; Kinetic theory; Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation; Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

2. Basics of the Lattice Boltzmann Method and Simulations:
   Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

3. Hands on:
   Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).

4. Practical issues of LBM for fluid dynamics simulations:
   Lattice Boltzmann simulations of turbulent flows; numerical stability and accuracy.

5. Microflow:
   Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.

6. Advanced lattice Boltzmann methods:
   Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.

7. Introduction to LB models beyond hydrodynamics:
   Relativistic fluid dynamics; flows with phase transitions.

The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.
### 151-0216-00L Wind Energy

**Abstract**
The objective of this course is to introduce the students to the fundamentals, technologies, modern day application, and economics of wind energy. These subjects are introduced through a discussion of the basic principles of wind energy generation and conversion, and a detailed description of the broad range of relevant technical, economic and environmental topics.

**Objective**
The objective of this course is to introduce the students to the fundamentals, technologies, modern day application, and economics of wind energy.

**Content**
This mechanical engineering course focuses on the technical aspects of wind turbines; non-technical issues are not within the scope of this technically oriented course. On completion of this course, the student shall be able to conduct the preliminary aerodynamic and structural design of the wind turbine blades. The student shall also be more aware of the broad context of drivetrains, dynamics and control, electrical systems, and meteorology, relevant to all types of wind turbines.

### 151-0235-00L Thermodynamics of Novel Energy Conversion and Technologies

**Abstract**
In the framework of this course we will look at a current electronic thermal and energy management strategies and novel energy conversion processes. The course will focus on component level fundamentals of these process and system level analysis of interactions among various energy conversion components.

**Objective**
This course deals with liquid cooling based thermal management of electronics, reuse of waste heat and novel energy conversion and storage systems such as batteries, fuel cells and micro-fuel cells. The focus of the course is on the physics and basic understanding of those systems as well as their real-world applications. The course will also look at analysis of system level interactions between a range of energy conversion components.

**Content**
Part 1: Fundamentals:
- Overview of exergy analysis, Single phase liquid cooling and micro-mixing;
- Thermodynamics of multi-component-systems (mixtures) and phase equilibrium;
- Electrochemistry;

Part 2: Applications:
- Basic principles of battery;
- Introduction to fuel cells;
- Reuse of waste heat from supercomputers
- Hotspot targeted cooling of microprocessors
- Microfluidic fuel cells

Part3: System- level analysis
- Integration of the components into the system: a case study
- Analysis of the coupled operations, identification of critical states
- Support to system-oriented design

**Lecture notes**
Lecture slides will be made available. Lecture notes will be available for some topics (in English).

**Prerequisites / notice**
The course will be given in English:
1. Mid-term examination: Mid-term grade counts as 20% of the final grade.
2. Final exam: Written exam during the regular examination session. It counts as 80% of the final grade.

### 151-0243-00L New Enterprises for Engineers

**Abstract**
Transforming Needs to opportunities for new technology enterprises,
- Links between entrepreneurship and product development/engineering.
- Sales, marketing, financing, and growth. Detailed Plans and execution.
- Survival through cash flow management.
- Human issues in new enterprise
- Alignment of interests.
- Transition of enterprises along growth path

**Objective**
Transforming Needs to Business Enterprises

**Goals of the course:**
- Propose the role of Needs-Driven Opportunities for new technology enterprises
- Explore links between entrepreneurship and engineering; such as problem solving, planning, system analysis, can-do attitude!
- Making it happen- through sales, marketing, planning, staffing, implementation, financing, and growth. Detailed Plans and execution
- Survival (and success) through cash flow management
- Explore the human issues in any new enterprise
- Alignment of interests between providers of value (founders and staff, VCs) and the providers of capital (Angels, VCs, Corporation)
- Transformations of enterprises along growth path

**Content**
Approach:
Weekly lectures including discussions of international case studies
Exercises to develop and present modules of new plans
Extensive class interactions capped with presentation by each (group) student of new enterprise plan

**Lecture notes**
Please see http://www.NEFE.ethz.ch

**Prerequisites / notice**
The course is primarily for engineering and natural science students at all levels who are interested in participating in the initiation or growth of a new enterprise. The new enterprise could be stand-alone start up or a new business unit for an existing enterprise.

The class is practical in nature but emphasizes the basic understanding of the parameters that significantly contribute to the success of a new enterprise. It will be highly interactive with special selected guests from Selected guests from; companies founder, venture capital and business angel, and large corporation executive. Class attendance and active participation is required.

### 151-0251-00L IC-Engines and Propulsion Systems I

**Abstract**
Introduction to basic concepts, operating maps and work processes of internal combustion engines. Thermodynamic analysis and design, scavenging methods, heat transfer mechanisms, turbulent flow field in combustion chambers, turbocharging. Energy systemic role of IC engines: conventional and electrified vehicle propulsion systems and decentralized power generation.

**Objective**
The students learn the basic concepts of an internal combustion engine by means of the topics mentioned in the abstract. This knowledge is applied in several calculation exercises and two lab exercises at the engine test bench. The students get an insight in alternative power train systems.

**Lecture notes**
in English

**Literature**
### 151-0368-00L
**Aeroelasticity**  
**W**  
4 credits  
2V+1U  
F. Campanile

**Abstract**  
Introduction to the basics and methods of Aeroelasticity. An overview of the main static and dynamic phenomena arising from the interaction between structural and aerodynamic loads.

**Objective**  
The course will give you a physical basic overview of current-structure phenomena. Furthermore you will get to know the most important phenomena in the statistical and dynamical aeroelastic as well as an introduction to the methods for mathematical descriptions and for the wording of quantitative forecasts.

**Content**  
- Rudernwirkung und -umkehr. Auswirkung der Flügelpfeilung auf statische aeroelastische Phänomene.
- Grundelemente der instationären Aerodynamik.

**Einführung in die Modalanalyse**  
Einführung in weitere Phänomene der dynamischen Aeroelastik.

**Literature**  

### 151-0709-00L
**Stochastic Methods for Engineers and Natural Scientists**  
W  
4 credits  
3G  
D. W. Meyer-Massetti, N. Noiray

**Abstract**  
The course provides an introduction into stochastic methods that are applicable for example for the description and modeling of turbulent and surface flows. Moreover, mathematical techniques are presented that are used to quantify uncertainty in various engineering applications.

**Objective**  
By the end of the course you should be able to mathematically describe random quantities and their effect on physical systems. Moreover, you should be able to develop basic stochastic models of such systems.

**Content**  
- Probability theory, single and multiple random variables, mappings of random variables
- Stochastic differential equations, Ito calculus, PDF evolution equations
- Polynomial chaos and other expansion methods

All topics are illustrated with application examples from engineering.

**Lecture notes**  
Detailed lecture notes will be provided.

**Literature**  
Some textbooks related to the material covered in the course:

### 151-0851-00L
**Robot Dynamics**  
W  
4 credits  
2V+1U  
M. Hutter, R. Siegwart, T. Stastny

**Abstract**  
We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

**Objective**  
The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

**Content**  
The course consists of three parts: First, we will refresh and deepen the student’s knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will be built upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

**Prerequisites / notice**  
The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.

### 151-0911-00L
**Introduction to Plasmonics**  
W  
4 credits  
2V+1U  
D. J. Norris

**Abstract**  
This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics. Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

**Content**  
- Fundamentals of Plasmonics
- Basic electromagnetic theory
- Optical properties of metals
- Surface plasmon polaritons on surfaces
- Surface plasmon polariton propagation
- Localized surface plasmons

Applications of Plasmonics
- Waveguides
- Extraordinary optical transmission
- Enhanced spectroscopy
- Sensing
- Metamaterials

**Lecture notes**  
Class notes and handouts

**Literature**  

**Physics I, Physics II**

### 151-0917-00L
**Mass Transfer**  
W  
4 credits  
2V+2U  
R. Büchel, S. E. Pratsinis

**Abstract**  
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Objective**  
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.
Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reaynolds- and Chilton-Colburn analogies for mass-, heat- and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.


**Content**

**Literature**

**Prerequisites / notice**

Two tests are offered for practicing the course material. Participation is mandatory.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0927-00L</td>
<td>Rate-Controlled Separations in Fine Chemistry</td>
<td>W 4 credits</td>
<td>3G</td>
<td>M. Mazzotti</td>
</tr>
<tr>
<td>151-0933-00L</td>
<td>Seminar on Advanced Separation Processes</td>
<td>Z 0 credits</td>
<td>1S</td>
<td>M. Mazzotti</td>
</tr>
<tr>
<td>151-0951-00L</td>
<td>Process Design and Safety</td>
<td>W 4 credits</td>
<td>2V+1U</td>
<td>P. Rudolf von Rohr</td>
</tr>
<tr>
<td>151-1116-00L</td>
<td>Introduction to Aircraft and Car Aerodynamics</td>
<td>W 4 credits</td>
<td>3G</td>
<td>J. Wildi</td>
</tr>
<tr>
<td>101-0187-00L</td>
<td>Structural Reliability and Risk Analysis</td>
<td>W 3 credits</td>
<td>2G</td>
<td>B. Sudret</td>
</tr>
</tbody>
</table>

**Abstract**

The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

The class covers separation techniques that are central in the purification and downstream processing of chemicals and bio-pharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

Handouts during the class

Recommendations for text books will be covered in the class

Research seminar for master's students and doctoral students

Research seminar for master's students and doctoral students

Process design and safety deals with the fundamentals of process apparatus, plant design and safety.

The goal of the lecture is to expound design characteristics of systems for process engineering applications.

Fundamentals of plant and apparatus design; materials in the process industries, mechanical design and design rules of main components; pumps and fans; piping and armatures, safety in process industry

Script is available, english slides will be distributed

Students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Handouts during the class

Recommendations for text books will be covered in the class

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Handouts during the class

Recommendations for text books will be covered in the class

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Fundamentals of plant and apparatus design; materials in the process industries, mechanical design and design rules of main components; pumps and fans; piping and armatures, safety in process industry

Script is available, english slides will be distributed

Students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.
### Acoustics

| Content | Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro-codes usually provide a framework that guarantees safety and reliability. However the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making. |
| The first part of the course is a reminder on probability theory that is used as a main tool for risk analysis and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented. |
| The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information. |
| The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented. |
| The course also includes a tutorial using the UQLab software dedicated to real world structural reliability analysis. |

### Lecture notes

| Literature | Slides of the lectures are available online every week. A printed version of the full set of slides is proposed to the students at the beginning of the semester. |
| Prerequisites / notice | Good foundation in electromagnetics & knowledge of microwave or optical communication is helpful. Whenever we deviate from the main material discussed in these books, softcopy of lectures notes will be provided. |

### Literature

- Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009
- S. Marelli, R. Schöbı, B. Sudret, UQLab user manual - Structural reliability (rare events estimation), Report UQLab-v0.92-107.

### Prerequisites / notice

- Basic course on probability theory and statistics

### Examination

Examination: written, 60 min, open books (Examination in German; Answers may be given in English)

### Technical visit

Technical visit: This course includes a guided tour at Zurich Airport (baggage sorting system, apron, ATC Tower).

### Lecture notes

| Literature | Literature will be provided by the lecturers respective there will be additional Information upon registration |
| Prerequisites / notice | We will also use English papers |

### Content

| Lecture notes | Slides are provided prior to each class |
| Literature | Literature will be provided by the lecturers respective there will be additional Information upon registration |
| Prerequisites / notice | We will also use English papers |

| 227-0455-00L | Terahertz: Technology & Applications |
| Content | This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting. |
| Objective | This is an introductory course on Terahertz (THz) technology and applications. Devices operating in THz frequency range (0.1 to 10 THz) have been increasingly studied in the recent years. Progress in nonlinear optical materials, ultrafast optical and electronic techniques has strengthened research in THz application developments. Due to unique interaction of THz waves with materials, applications with new capabilities can be developed. In theory, they can penetrate somewhat like X-rays, but are not considered harmful radiation, because THz energy level is low. They should be able to provide resolution as good or better than magnetic resonance imaging (MRI), possibly with simpler equipment. Imaging, very-high bandwidth communication, and energy harvesting are the most widely explored THz application areas. We will study the basics of THz generation, manipulation, and detection. Our emphasis will be on the physical principles and applications of THz in the domain of imaging, communication and energy harvesting. |

### Examination

Examination: written, 60 min, open books (Examination in German; Answers may be given in English)

### Technical visit

Technical visit: This course includes a guided tour at Zurich Airport (baggage sorting system, apron, ATC Tower).

### Lecture notes

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### Content

| Lecture notes | Slides are provided prior to each class |
| Literature | Literature will be provided by the lecturers respective there will be additional Information upon registration |
| Prerequisites / notice | We will also use English papers |

| 227-0545-00L | Terahertz: Technology & Applications |
| Content | INTRODUCTION
Chapter 1: Introduction to THz Physics
Chapter 2: Components of THz Technology THz TECHNOLOGY MODULES
Chapter 3: THz Generation
Chapter 4: THz Detection
Chapter 5: THz Manipulation APPLICATIONS
Chapter 6: THz Imaging
Chapter 7: THz Communication
Chapter 8: THz Energy Harvesting - Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009

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Examination: written, 60 min, open books (Examination in German; Answers may be given in English)

### Technical visit

Technical visit: This course includes a guided tour at Zurich Airport (baggage sorting system, apron, ATC Tower).

### Lecture notes

| Literature | Literature will be provided by the lecturers respective there will be additional Information upon registration |
| Prerequisites / notice | We will also use English papers |

### Content

| Lecture notes | Slides are provided prior to each class |
| Literature | Literature will be provided by the lecturers respective there will be additional Information upon registration |
| Prerequisites / notice | We will also use English papers |

| 227-0950-00L | Acoustics |
| Content | Good foundation in electromagnetics & knowledge of microwave or optical communication is helpful. |

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1039 of 1571
Abstract

Lecture notes will be distributed electronically during the course.

Content

Scenarios for the development of world primary energy consumption, energy intensity and economic development. Energy conversion chains, see above

Objective

Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.

Literature

Lecture notes

Handouts during course

Prerequisites / notice

Fundamentals of chemistry, physics and thermodynamics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

636-0001-00L

Separations in Biotechnology and Bioprocesses

Economy

W 6 credits 3G S. Panke

Abstract

Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select & roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations & judge on process economy.

Objective

Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.

Content

Introduction membrane operations adsorption and chromatography crystallization overall process economics

Lecture notes

Handouts during course

Prerequisites / notice

636-0507-00L

Synthetic Biology II

W 4 credits 4A S. Panke, Y. Benenson, J. Stelling

Abstract

7 months biological design project, during which the students are required to give presentations on advanced topics in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

Objective

The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

Content

Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external,) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Lecture notes

Handouts during course

Prerequisites / notice

The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc. This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

Number

Title

Uncertainty Quantification for Engineering & Life Sciences

W 4 credits 3G P. Koumoutsakos

Abstract

Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective

The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content

Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature

1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice

Fundamentals of Probability, Fundamentals of Computational Modeling

151-0107-20L

High Performance Computing for Science and W 4 credits 4G M. Troyer, P. Chatzidoukas
**Engineering (HPCSE) I**

**Abstract**
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

**Objective**
Introduction to HPC for scientists and engineers  
Fundamental of:  
1. Parallel Computing Architectures  
2. MultiCores  
3. ManyCores

**Content**
Programming models and languages:  
1. C++ threading (2 weeks)  
2. OpenMP (4 weeks)  
3. MPI (5 weeks)
Computers and methods:  
1. Hardware and architectures  
2. Libraries  
3. Particles: N-body solvers  
4. Fields: PDEs  
5. Stochastics: Monte Carlo

**Lecture notes**
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

<table>
<thead>
<tr>
<th>151-0317-00L</th>
<th>Visualization, Simulation and Interaction - Virtual Reality II</th>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>A. Kunz</th>
</tr>
</thead>
</table>

**Abstract**
This lecture provides deeper knowledge on the possible applications of virtual reality, its basic technology, and future research fields. The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes.

**Objective**
Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems.  
The goal of the lecture is to provide a deeper knowledge of today’s VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.

**Content**
Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of simulation; compression procedures of image-, audio-, and video signals; new materials for force feedback devices; introduction into data security; cryptography; definition of free-form surfaces; digital factory; new research fields of virtual reality

**Lecture notes**
The handout is available in German and English.

**Prerequisites / notice**
Prerequisites:  
"Visualization, Simulation and Interaction - Virtual Reality I” is recommended.

**Didactical concept:**
The course consists of lectures and exercises.

<table>
<thead>
<tr>
<th>151-0349-00L</th>
<th>Fatigue Strength of Materials, Components and Structures</th>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>M. Guillaume, R. E. Koller</th>
</tr>
</thead>
</table>

**Abstract**
Fatigue of materials is playing a key role in light weight structures. All applications are affected that are exposed to oscillating loads. The lecture will present the most important methods for analyzing the fatigue strength under service load conditions. This starts with the conventional assessment of a components endurance limit and ends with the application of the damage tolerance philosophy.

**Objective**
Goals of the lecture  
An introduction to the most important terms and phenomena related to fatigue damages of metallic components will be given and explained by practical examples. Methods for assessment of endurance strength, finite life fatigue strength, crack initiation and crack growth will be discussed. The lecture shall demonstrate how to solve fatigue problems in practice.  
Examples like the ICE disaster at Eschede or structural problems of the Combino tram demonstrate the significance of this subject. The fatigue behavior of lightweight structures for vehicles and aircrafts has to be considered during the component design process. Designing the static strength of a component alone is not sufficient since fatigue damages of such components may cause extremely high costs.  
Structural components of modern aircraft like Airbus A380 or A400M are designed with respect to crack growth using the damage tolerance philosophy.  
Understanding fatigue strength and its phenomena requires broad knowledge of material behavior, services loads, manufacturing effects as well as of analysis and test methods. Fatigue strength is a highly interdisciplinary area of work. For this the most important tools and methods shall be presented.
Content

1. INTRODUCTION, OVERVIEW, MOTIVATION
   1.1 Preface (General introduction and history survey) (Schijve; Chapter 1)
   1.2 Standards and Guidelines
   1.3 Examples of damage events
      Comet-Accident (Pressure cycles, stress concentration)
      Aloha-Incident at Hawaii (Multiple site damage)
      Accident of an aerial passenger tramway (Fretting corrosion on axle)
      ICE-Accident (Wheel failure)
   1.4 Presentations
      DVD "MTW Materialermüdung (1995, 21')",
      DVD "F/A-18 Full Scale Fatigue Test (2004, 12')",
      DVD "Sicherheit von Seilbahnen (1996, 7')" with discussion

2. LOADING
   2.1 Fatigue strength overview
   2.2 Significance of operational loading
   2.3 Types of load histories (Schijve; Chapter 9)
   2.4 Terms and definitions (Schijve; Chapter 9)
   2.5 Measurement of operational loadings (Schijve; Chapter 9)
   2.6 Counting algorithms (Schijve; Chapter 9)
   2.7 Frequency distributions or spectra (Schijve; Chapter 9)
   2.8 Impact of spectrum shape
   2.9 Design Spectra (Schijve; Chapter 13)

3. MATERIAL
   3.1 Fatigue strength overview
   3.2 Evaluation of material properties for cyclic loading (Schijve; Chapter 13)
   3.3 Fatigue properties (Schijve; Chapter 6)
   3.4 Wöhler-Diagram (Schijve; Chapter 6, 7)
   3.5 Scatter of fatigue properties (Schijve; Chapter 12)
   3.6 Mean stress effect (Schijve; Chapter 6)
   3.7 Damage mechanisms & material selection (Schijve; Chapter 2)
   3.8 Environmental effects (Schijve; Chapter 16, 17)
   3.9 Specific fatigue properties (Schijve; Chapter 6)

4. STRUCTURAL COMPONENT
   4.1 Fatigue strength overview
   4.2 Notches (Schijve; Chapter 3, 7)
   4.3 Residual stresses (Schijve; Chapter 4)
   4.4 Size effect
   4.5 Surface condition and surface layers (Schijve; Chapter 7, 14)
   4.6 Fretting corrosion (Schijve; Chapter 15)
   4.7 Summary of fatigue strength improving methods (Schijve; Chapter 14)

5. SAFETY FACTORS (Schijve; Chapter 19)

6. FATIGUE STRENGTH ASSESSMENT
   6.1 Fatigue strength overview
   6.2 Assessment concepts for fatigue lifetime prediction
   6.3 Assessment of the endurance strength
   6.4 Finite life fatigue strength assessment using the nominal stress concept (Schijve; Chapter 10)
   6.5 Local stress-strain concept (Schijve; Chapter 10)
   6.6 Fracture mechanics concept (Schijve; Chapter 5, 8, 11)
   6.7 Accuracy of concepts for fatigue lifetime assessment

7. STRUCTURAL INTEGRITY CONCEPTS
   7.1 Safe life design (Mirage III, Pressure Vessel)
   7.2 Fail safe design (modern aircraft construction)
   7.3 Damage tolerance (approach according to US Air Force)
   7.4 F/A-18 design philosophy
   7.5 Summary

8. EXPERIMENTAL FATIGUE STRENGTH
   8.1 In case of interesting current tests laboratory visitation at Empa

Lecture notes
All lecture chapters are on Powerpoint presentations. The chapters will be available as presentation handouts at the first day for a fee of
CHF 20.-

Literature
Recommended books as supplement to the lecture:

Schijve, Jaap
Fatigue of Structures and Materials

Broek, David
The Practical Use of Fracture Mechanics

Prerequisites / notice
Depending on actual fatigue tests a Laboratory visitation at Empa in Dübendorf may be organized.

151-0353-00L Mechanics of Composite Materials W 4 credits 2V+1U G. Kress
Abstract
The course Mechanics of Composite Materials is dedicated to modeling problems following from the complex mechanical behavior of these
anisotropic material structures. and modeling of continuous fibre reinforced composites. Participants will be able to design parts for the
mechanical, automotive and aerospace industry.

Objective
Understanding of the mechanical properties of fiber reinforced composites with regard to analysis and design of lightweight structures for
mechanical, transportation and aerospace applications.
Cable cars and cable cranes: Construction methods and areas of application. The use of mechanical principles in system engineering, cable cars make use of extensive mechanical systems, which because of their operational location, are exposed to difficult meteorological and topographical conditions. In order to guarantee the requisite safety and reliability of the equipment, the components and their interaction in the system must fulfill stringent functional requirements. This is particularly the case because of the significant distance (2-4km) between the individual structures. The lectures with related exercises offer an excellent opportunity to apply the learned theoretical basic principles of mechanics and engineering in plant construction. Not only the function and resistance of individual components will be studied, but also complex interactions, which are imperative for the safe and smooth running of the equipment. It also includes the teaching of the basics of project planning and design, as well as the evaluation of systems in a distinctly interdisciplinary manner. For the manufacturer of a cable car installation the integration of sub-assemblies making use of very different technologies always poses a particular challenge. For this reason, the methodology for the handling of these typical engineering assignments is important and makes up a significant part of the lecture content.

Content

Cable cars and cable cranes: Construction methods and areas of application. The use of mechanical principles in system engineering, Swiss building and business regulations, planning and equipment with special consideration for business and the environment: steel cables (construction, evaluation, damage, inspection), drive mechanisms, brakes, vehicles, construction over an extended area. Calculation of the supporting cable with weight strain and with fixed mountings on both sides. Excursions.

Lecture notes

SEILBAHNEN I

151-0357-00L

Ropeway Technology

W 4 credits 3G G. Kovacs

Abstract

Ropeways represent a public transport system where steel wired ropes play a central role. Such systems come to a favorit transport solution when the costs for conventional systems become out of scale due to difficult and impossible terrestrial surface (alpine terrain). Additionally ropeways are environment friendly, very energy efficient and offer a very high safety level.

Objective

Cable cars make use of extensive mechanical systems, which because of their operational location, are exposed to difficult meteorological and topographical conditions. In order to guarantee the requisite safety and reliability of the equipment, the components and their interaction in the system must fulfill stringent functional requirements. This is particularly the case because of the significant distance (2-4km) between the individual structures. The lectures with related exercises offer an excellent opportunity to apply the learned theoretical basic principles of mechanics and engineering in plant construction. Not only the function and resistance of individual components will be studied, but also complex interactions, which are imperative for the safe and smooth running of the equipment. It also includes the teaching of the basics of project planning and design, as well as the evaluation of systems in a distinctly interdisciplinary manner. For the manufacturer of a cable car installation the integration of sub-assemblies making use of very different technologies always poses a particular challenge. For this reason, the methodology for the handling of these typical engineering assignments is important and makes up a significant part of the lecture content.

Content

Cable cars and cable cranes: Construction methods and areas of application. The use of mechanical principles in system engineering, Swiss building and business regulations, planning and equipment with special consideration for business and the environment: steel cables (construction, evaluation, damage, inspection), drive mechanisms, brakes, vehicles, construction over an extended area. Calculation of the supporting cable with weight strain and with fixed mountings on both sides. Excursions.

Lecture notes

SEILBAHNEN I

151-0360-00L

Procedures for the Analysis of Structures

W 4 credits 2V+1U G. Kress

Abstract

Basic theories for structure integrity calculations are presented with focus on strength, stability, fatigue and elasto-plastic structural analysis. Theories and models for one dimensional and planar structures are presented based on energy theorems.

Objective

Basic principles applied in structural mechanics. Introduction to the theories of planar structures. Development of an understanding of the relationship between material properties, structural theories and design criteria.

Content

1. Basic problem of continuum mechanics and energy principles: structural theories, homogenization theories; finite elements; fracture mechanics
2. Structural theories for planar structures and stability: plane-stress, plate theory, buckling of plates (non-linear plate theory)
3. Strength of material theories and material properties: ductile behaviour, plasticity, von Mises, Tresca, principal stress criterion; brittle behaviour; viscoplastic behaviour, creep resistance.
4. Structural design: fatigue and dynamic structural analysis.

Lecture notes

yes

151-0368-00L

Aeroelasticity

W 4 credits 2V+1U F. Campanile

Abstract

Introduction to the basics and methods of Aeroelasticity. An overview of the main static and dynamic phenomena arising from the interaction between structural and aerodynamic loads.

Objective

The course will give you a physical basic overview of current-structure phenomena. Furthermore you will get to know the most important phenomena in the statistical and dynamical aeroelastic as well as an introduction to the methods for mathematical descriptions and for the wording of quantitative forecasts.

Content


Literature


151-0509-00L

Microscale Acoustofluidics

W 4 credits 3G J. Dual

Abstract

In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

Objective

Understanding acoustophoresis, the design of devices and potential applications

Content

Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity. Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microfluidics to surface acoustic wave devices

Lecture notes


Literature


Prerequisites / notice

Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

151-0513-00L

Mechanics of Soft Materials and Tissues

W 4 credits 3G A. E. Ehret

Abstract

An introduction to concepts for the constitutive modelling of highly deformable materials with non-linear properties is given in application to rubber-like materials and soft biological tissues. Related experimental methods for materials characterization and computational methods for simulation are addressed.

Objective

The objective of the course is to provide an overview of the wide range of non-linear mechanical behaviors displayed by soft materials and tissues together with a basic understanding of their physical origin, to familiarize students with appropriate mathematical concepts for their modelling, and to illustrate the application of these concepts in different fields in mechanics.
Content
Soft solids: rubber-like materials, gels, soft biological tissues
Non-linear continuum mechanics: kinematics, stress, balance laws
Mechanical characterization: experiments and their interpretation
 Constitutive modeling: basic principles
Large strain elasticity: hyperelastic materials
Rubber-elasticity: statistical vs. phenomenological models
Biomechanics of soft tissues: composites, anisotropy, heterogeneity
Dissipative behavior: examples and the concept of internal variables.

Lecture notes
Accompanying learning materials will be provided or made available for download during the course.

Literature
Recommended text:
L.R.G. Treloar, The physics of rubber elasticity, 3rd ed., 2005

Prerequisites / notice
A good knowledge base in continuum mechanics, ideally a completed course in non-linear continuum mechanics, is recommended.

151-0517-00L
Scientific Visualization for Engineering Applications

Abstract
The course offers an introduction to the basic principles and most prominent methods of scientific visualization in science and engineering applications. The presentation will cover mathematical models and algorithms that support the depiction of 2D, 3D, and time-dependent datasets comprised of scalar, vector, and tensor attributes.

Objective
The course offers a self-contained introduction scientific visualization with an emphasis on basic principles and techniques that are most relevant to scientific and engineering applications.

The specific learning objectives are the following:
(1) Basics: elementary notions of computer graphics and visual perception
(2) Data processing: Relevant spatial data structures and smooth data reconstruction
(3) Colors: Proper usage of colors in visualization
(4) Scalar visualization: Level sets, salient surfaces, volume rendering and transfer function design
(5) Vector visualization: Integral curves and surfaces, dense representation
(6) Tensor visualization: Glyphs and integral curves
(7) flow visualization: automatic feature extraction and structure characterization
(8) Visual abstraction: topological skeleton
(9) Data analysis: visual exploration of numerical datasets.

Content
- Graphics primer
- Data structures and spatial queries
- Smooth data reconstruction
- Color perception
- Color mapping
- Isosurfaces (level sets)
- Ridges
- Direct volume rendering and transfer function design
- Integral curves and surfaces
- Texture-based flow representations
- Tensor glyphs and curves
- Topological methods for scalar, vector, and tensor fields
- Multifield techniques
- Visualization software

Lecture notes
Course slides and relevant papers

Literature
N/A

Prerequisites / notice
Basic programming knowledge

151-0523-00L
Railway Vehicle Dynamics

Abstract
After an introduction in to the railway vehicle design, the modelling of the contact between wheel and rail, the building of a simulation model and the fundamentals of the track guiding will be explained. The applications of simulations in the development of railway vehicles will be presented and illustrated on examples.

Objective
Development of the theoretical basics regarding the track guiding and the vehicle running dynamics. Understanding the background of multi-body dynamics simulation tools and their application in the development of railway vehicles.

Content
Introduction in to railway vehicle technology: Vehicle concepts, bogies, suspension systems, brakes, drives.
Use of multi-body simulations in the railway vehicle industry. Simulation programmes.
Vehicle model: Model building, modelling of coil springs, rubber to metal springs, air springs and suspension components with friction.
Wheel/rail contact: Contact geometry, contact area, normal forces, tangential forces.
Track models. Modelling of track irregularities.
Linearization of the contact geometry wheelset-track.
Fundamentals of track guiding.
Eigenbehaviour, calculation of eigenvalues.
Linearised and nonlinear calculation of running stability: Methods and assessment criteria. Influence of vehicle design on the running stability.
Ride comfort assessment.
Testing and simulations for the acceptance of running characteristics of railway vehicles. Validation of simulation models for the application in context of vehicle acceptance.

Lecture notes
Script will be provided.

Prerequisites / notice
Fundamentals of mechanics and physics.

151-0524-00L
Continuum Mechanics I

Abstract
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

Objective
Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

Content

Lecture notes
yes

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Wave Propagation in Solids

Abstract
Plane Waves, harmonic waves, Fourier analysis and synthesis, dispersion, distortion, damping, group and phase velocity, transmission and reflection, impact, waves in linear elastic continua, elastic plastic waves, experimental and numerical methods in wave propagation.

Objective
Students learn, which technical problems must be approached using the methods used in wave propagation in solids. Furthermore, they learn to use these methods and develop an intuitive feeling for phenomena that can be expected in various situations.

Content
Wave Propagation in solids including applications.

Nonlinear Dynamics and Chaos I

Abstract
Basic facts about nonlinear systems; stability and near-equilibrium dynamics; bifurcations; dynamical systems on the plane; non-autonomous dynamical systems; chaotic dynamics.

Objective
This course is intended for Masters and Ph.D. students in engineering sciences, physics and applied mathematics who are interested in the behavior of nonlinear dynamical systems. It offers an introduction to the qualitative study of nonlinear physical phenomena modeled by differential equations or discrete maps. We discuss applications in classical mechanics, electrical engineering, fluid mechanics, and biology.

Content
(1) Basic facts about nonlinear systems: Existence, uniqueness, and dependence on initial data.
(2) Near equilibrium dynamics: Linear and Lyapunov stability
(3) Bifurcations of equilibria: Center manifolds, normal forms, and elementary bifurcations
(4) Nonlinear dynamical systems on the plane: Phase plane techniques, limit sets, and limit cycles.
(5) Time-dependent dynamical systems: Floquet theory, Poincare maps, averaging methods, resonance

Prerequisites / notice
- Prerequisites: Analysis, linear algebra and a basic course in differential equations.
- Exam: two-hour written exam in English.
- Homework: A homework assignment will be due roughly every other week. Hints to solutions will be posted after the homework due dates.

Optical Methods in Experimental Mechanics

Abstract
The lecture introduces a variety of optical methods to assess the mechanical behaviour of a structure, to determine material parameters, or to validate results from numerical analysis. Focus is on camera-based techniques for deformation, strain and stress analysis. Applications and limitations will be discussed. The lecture includes two afternoons of hands-on experience at Empa in Dubendorf.

Objective
The students are able to design simple optical set-ups and describe the process of image formation. They understand the working principle of various camera-based techniques for shape, deformation and strain measurement. Most notably they can explain how the measurement is transformed into an interference signal, a change of polarization or surface temperature. They know the main application fields of the individual techniques. They are able to choose the most appropriate technique for solving a measurement task and to estimate its expected resolution. Through the hands-on experience the students gain a deeper and sustained understanding of the content by applying the theoretical foundations to dedicated measurement tasks.

Content
After an introduction into optics and image acquisition the lecture explains how to transform mechanical quantities such as strain, stress or deformation into an image content. The imaging measurement techniques make use of a variety of optical principles:
- Triangulation (Digital Image Correlation, Fringe Projection)
- Interference (Speckle Pattern Interferometry, Shearography)
- Diffraction (Moire-Interferometry, Fiber Bragg Gratings)
- Birefringence (Photelasticity)
- Infrared radiation (Thermal Stress Analysis)

In addition, dynamic measurements and vibration analysis are explained in the context of modal analysis or transient events. The calibration of imaging optical methods and their application to the validation of numerical simulations are described.

The content is structured as follows:
1. Imaging methods: an introduction
2. Digital Image Correlation
3. White light moiré methods
4. Interferometry
5. Deformation analysis: Speckle pattern interferometry
6. Strain analysis: Shearography
7. Modal analysis
8. Measurement of transient deformations
9. Stress analysis: Photoelasticity
10. Stress analysis: Thermoelasticity
11. Validation of FEA results and calibration of optical full-field methods
12. Fibre based methods

Prerequisites / notice
- Prerequisites: Analysis, linear algebra and a basic course in differential equations.
- Exam: two-hour written exam in English.
- Homework: A homework assignment will be due roughly every other week. Hints to solutions will be posted after the homework due dates.

Literature
Various books will be recommended pertaining to the topics covered.

Lecture notes
Copies of the presented slides will be made available on-line through ILIAS. You will be invited to a private blog which will stimulate the discussion of the lecture and the exercises.
Adaptive Materials for Structural Applications

Adaptive materials offer appealing ways to extend the design space of structures by introducing time-variable properties into them. In this course, the physical working principles of selected adaptive materials are analyzed and simple models for describing their behavior are presented. Some applications are illustrated, also with laboratory experiments where possible.

The objective of this course is to convey knowledge about adaptive materials, their properties and the physical mechanisms that govern their function, so as to develop the skills to deal with this interdisciplinary subject.

Content

This course will provide the students with an insight into the properties and physical phenomena which lead to the features of adaptive materials. Starting from chemomechanical (skeletal muscles), the physical behavior of a wide range of adaptive materials, thermo- and photo-mechanical, electro-mechanical, magneto-mechanical and meta-materials will be thoroughly discussed and analyzed. Up-to-date results on their performance and their implementation in mechanical structures will be detailed and studied in laboratory sessions. Analytical tools and energy based considerations will provide the students with effective instruments for understanding adaptive materials and assess their performance when integrated in structures or when arranged in particular fashions.

Basic concepts: Power conjugated variables, dissipative effects, geometry- and materials-based energy conversion

Thermo-mechanical coupling: Energy conversion in skeletal muscle and other chemomechanical systems, optional: and photo-mechanical coupling, azopolymers.

Electromechanical coupling (1): DEA, EBL, electro rheological fluids

Shape control / morphing: Use, requirements, challenges

Morphing applications of variable stiffness structures: Lab work

Electromechanical coupling (2): Piezoelectric, electrostrictive effect

Vibration Reduction: Measurement, passive, semi-active (active) damping methods

Vibration reduction applications of piezoelectric materials: Lab work

Metamaterials: Definition of metamaterials - electromagnetic, acoustical and other metamaterials

Magneto-mechanical coupling: Magnetostriuctive effect, mSMA, magnetotherioelitical fluids, ferrofluids

Energy harvesting and sensing: Energy harvesting with EAP and piezoelectric materials, transducers as sensors: Piezo, resistive,....

Lecture notes (manuscript and handouts) will be provided

System Modeling


Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data.

Examples: mechatronic, thermodynamic, chemistry, fluid dynamic, energy, and process engineering systems. Model scaling, linearization, order reduction, and balancing. Estimation techniques (least-squares methods).

Class case studies: Loud-speaker, Water-propelled rocket, geostationary satellites, etc.

The exercises address practical examples. One larger case study is to be solved.

The handouts in English will be sold in the first lecture.

A list of references is included in the handouts.

Skills for Creativity and Innovation

This lecture aims to enhance the knowledge and competency of students regarding their innovation capability. An overview on prerequisites and different skills for creativity and innovation in individual & team settings is given. The focus of this lecture is clearly on building competencies - not just acquiring knowledge.

- Basic knowledge about creativity and skills
- Knowledge about individual prerequisites for creativity
- Development of individual skills for creativity
- Knowledge about teams
- Development of team-oriented skills for creativity
- Knowledge and know-how about transfer to idea generation teams

Lecture notes (manuscript and handouts) will be distributed. Solving them is warmly recommended.

The two afternoons with hands-on experience are central elements of the lecture.

Prerequisites / notice

Basic knowledge of optics and interferometry as taught in basic physics courses are advantageous. Every week exercises will be distributed. Solving them is warmly recommended.
F. Kuster

K. Wegener

Assembly as combination of several classes of action like, e.g., joining, handling, fine adjustments, etc. Techniques for joining objects

M. Boccadoro,

2V+1U

P. Acél

Deepened discussion on the machining processes and their optimisation. Outlook on additional areas such as NC-Technique, dynamics of

yes

Manufacturing I

The student learns the right use of (Who? When? How?) of the event-driven and computer-based simulation in the illustration of the

Understanding of the complexity of the assembly process as well as its meaning as success and cost factor. The assembly with the

Basic knowledge about creativity and skills:

- Introduction into creativity & innovation: definitions and models

Knowledge about individual prerequisites for creativity:

- Personality, motivation, intelligence

Development of individual skills for creativity:

- Focus on creativity as problem analysis & solving
- Individual skills in theoretical models
- Individual competencies: exercises and reflection

Knowledge about teams:

- Definitions and models
- Roles in innovation processes

Development of team-oriented skills for creativity:

- Idea generation and development in teams
- Cooperation & communication in innovation teams

Knowledge and know-how about transfer to idea generation teams:

- Self-reflection & development planning
- Methods of knowledge transfer

Lecture notes

Slides, script and other documents will be distributed via moodle.ethz.ch

(access only for students registered to this course)

Please refer to lecture script.

Literature

151-0703-00L

Operational Simulation of Production Lines

W 4 credits 2V+1U P. Acél

Objective

The student learns the application of the event-driven and computer-based simulation for layout and operational improvement of production facilities by means of practical examples.

Content

- Application and application areas of the event-driven simulation
- Exemplary application of a software tool (Technomatrix-Simulation-Software)
- Internal organisation and functionality of simulation tools
- Procedure for application: optimizing, experimental design planning, analysis, data preparation
- Controlling philosophies, emergency concepts, production in sequence, line production, rescheduling
- Application on the facilities projecting

Lecture notes

The knowledge is enhanced by practice-oriented exercises and an excursion. A guest speaker will present a practical example.

Prerequisites / notice

Recommended for all Bachelor-Students in the 5th semester and Master-Students in the 7th semester.

151-0705-00L

Manufacturing I

W 4 credits 2V+2U K. Wegener, M. Boccadoro, F. Kuster

Objective


Content

- Deepened discussion on the machining processes and their optimisation. Outlook on additional areas such as NC-Technique, dynamics of processes and machines, chatter as well as process monitoring.

Lecture notes

Recommended: Lecture 151-0700-00L Manufacturing elective course in the 4th semester.

Prerequisites / notice

Language: Help for English speaking students on request as well as english translations of the slides shown.

151-0717-00L

Mechanical Production: Assembly, Joining and Coating Technology

W 4 credits 2V+1U F. Kuster, V. H. Derflinger, F. Durand, P. Jousset

Objective

Understanding of the complexity of the assembly process as well as its meaning as success and cost factor. The assembly with the different aspects of adding, moving, adjusting, controlling parts etc.. Adding techniques; solvable and unsolvable connections. Assembly plants. Coating techniques and their tasks, in particular corrosion protection.

Objective

To understand assembly in its full complexity and its paramount importance regarding cost and financial success. An introduction into a choice of selected joining and coating techniques.

Content

Assembly as combination of several classes of action like, e.g., joining, handling, fine adjustments, etc. Techniques for joining objects temporarily or permanently. Assembly systems.

Coating processes and their specific applications, with particular emphasis on corrosion protection.

Lecture notes

Recommended to the focus production engineering. Majority of lecturers from the industry.

Prerequisites / notice

151-0719-00L

Quality of Machine Tools - Dynamics and Metrology at Micro and Submicro Level

W 4 credits 2V+1U W. Knapp, F. Kuster

Objective

The course "Machine tool metrology" deals with the principal design of machine tools, their spindles and linear axes, with possible geometric, kinematic, thermal and dynamic errors of machine tools and testing these errors, with the influence of errors on the workpiece (error budgeting), with testing of drives and numerical control, as well as with checking the machine tool capability.

Knowledge of

- principal design of machine tools
- errors of linear and rotational axes and of machine tools,
- influence of errors on the workpiece (error budgeting)
- dynamics of mechanical systems
- geometric, kinematic, thermal, dynamic testing of machine tools
- test uncertainty
- machine tool capability
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<th>Course Code</th>
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<tbody>
<tr>
<td>151-0721-00L</td>
<td>Production Machines II</td>
<td>4</td>
<td>K. Wegener, F. Kuster, S. Weikert</td>
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</tbody>
</table>

**Abstract**
Control, closed loop control, processing of geometrical data, main drives, noise, flexibility, rationalization and automation, modern machine concepts, thermal and dynamic behavior.

**Objective**
Deeper competence for evaluation and development of production machines, sensibilization for unconventional kinematics with their advantages and drawbacks.

**Content**
Control (PLC, NC), closed loop control, processing of geometrical data, main drives, noise emission, flexibility, rationalization and automation, modern machine concepts like high speed machines, alternative kinematics, ultraprecision machines, thermal and dynamic behavior of machine tools, flexibility, rationalization and automation, practical case studies.

**Lecture notes**
Help for English speaking students on request. Parts of the lecture are held in English.

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<tr>
<td>151-0723-00L</td>
<td>Manufacturing of Electronic Devices</td>
<td>4</td>
<td>A. Kunz, A. Guber, R.D. Morison, F. Reichert</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture follows the value added process sequence of electronic and electronic components. It contains: Development of electronic and electronic circuits, design of electronic circuits on printed circuit boards as well as in hybrid technology, integrated test technology, planning of production lines, production of highly integrated electronic on a wafer as well as recycling.

**Objective**
Knowledge about the value added process sequence for electronics manufacturing, planning of electric and electronic product as well as their production, planning of production lines, value added process sequence for photovoltaics.

**Content**
Nothing works without electronics! Typical products in mechanical engineering such as machine tools, as well as any kind of vehicle contain a significant amount of electronic or electronic components of more than 60%. Thus, it is important to master the value added process sequence for electric and electronic components.

**Lecture notes**
Lecture notes are handed out during the individual lessons (CHF 20.-).

**Prerequisites**
Help for English speaking students on request.

The lecture is partly given by experts from industry. It is supplemented by an excursion to one of the industry partners.

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<tr>
<td>151-0727-00L</td>
<td>Colloquium on Manufacturing Technology</td>
<td>4</td>
<td>K. Wegener, F. Kuster</td>
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</table>

**Abstract**
Future training on selected current topics of the manufacturing technology. Per afternoon a selected topic is presented in several lectures, by the majority by experts from the industry. The students prepare a summary of the lectures given and prepare themselves on the basis of these lectures and own information search.

**Objective**
Continuous further training to current topics of the manufacturing technique. Exchange of experience and knowledge with the industry and other universities.

**Content**
Selected actual topics on manufacturing methods and tools, machine tools, NC-control and drives, components and measuring methods and devices. Topics are changing every year.

**Lecture notes**
Lecture notes are handed out during the individual lessons (CHF 20.-).

**Prerequisites / notice**
- Students must have participated and passed the courses Manufacturing, Production Machines I and Forming Technology III - Forming Processes.
- Further training with specialized lectures and large participation from the industry.

Language: Help for English speaking students on request.

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<tr>
<td>151-0731-00L</td>
<td>Forming Technology I - Basic Knowledge</td>
<td>4</td>
<td>P. Hora</td>
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</tbody>
</table>

**Abstract**
The fundamentals of forming technology are presented to Mechanical, Production and Material Engineers. The content of the lecture is: Overview of manufacturing with forming techniques, deformation specific description of material properties and their experimental measurement, material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure.

**Objective**
Forming technology represents with its 70% global share in manufactured metal volume with respect to yield and cost, the most important manufacturing process in metal-working industries. Typical applications of forming technology range from the manufacturing of sheet metal components in auto bodies to applications in food and pharma packaging, fabrication of implants in medical technologies and to the fabrication of leads in microelectronic components. This course introduces the fundamentals which are essential to evaluate metal-forming processes and its industrial applications. This includes, together with the requirements of the most important forming processes, the characterization of plastic material behavior and manufacturing limits.

**Content**
Overview of the most important processes of metal-forming technology and its field of applications, characterization of the plastic metal-forming behavior, basic principles of plasto-mechanical calculations, metal-forming residual stresses, thermo-mechanical coupling of metal-forming processes, influence of tribology, Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery.

**Lecture notes**
Yes

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<th>Credits</th>
<th>Prerequisites</th>
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<tbody>
<tr>
<td>151-0733-00L</td>
<td>Forming Technology III - Forming Processes</td>
<td>4</td>
<td>P. Hora</td>
</tr>
</tbody>
</table>

**Abstract**
Characterization of plastic material behavior and manufacturing limits.

**Content**
Overview of the most important processes of metal-forming technology and its field of applications, characterization of the plastic metal-forming behavior, basic principles of plasto-mechanical calculations, metal-forming residual stresses, thermo-mechanical coupling of metal-forming processes, influence of tribology, Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery.
Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.

Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering.

Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;

Various books will be recommended covering the topics discussed in class

The course "Leading and Coaching Focus Project Teams (Advanced Course)" for Spring Semester with 4 ECTS.

This course is the first part of a two-semester course.

The course "Leading and Coaching Focus Project Teams (Basic Course)" for Autumn Semester is examined together with the course "Leading and Coaching Focus Project Teams (Advanced Course)" for Spring Semester with 4 ECTS.

The course "Leading and Coaching Focus Project Teams (Basic Course)" (HS) is examined together with "Leading and Coaching Focus Project Teams (Advanced Course)" (FS) in FS with 4 ECTS.

Autumn Semester 2016

Please refer to lecture script.

Participants (Students, PhD Students, Postdocs) should be part of the coaching team of focus project teams.

The course "Leading and Coaching Focus Project Teams (Basic Course)" (HS) is examined together with "Leading and Coaching Focus Project Teams (Advanced Course)" (FS) in FS with 4 ECTS.
The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:

- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations.

### Content

- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

### Prerequisites

- 3V+1U

### Literature


### Lecture notes

Yes

### Prerequisites / notice

If we will have a large number of students, two dates for the exercises will be offered.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>W</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0917-00L</td>
<td>Mass Transfer</td>
<td>4</td>
<td>2V+2U</td>
<td>R. Büchel, S. E. Pratsinis</td>
</tr>
<tr>
<td>151-3203-00L</td>
<td>Grand Challenges in Engineering Design</td>
<td>1</td>
<td>3S</td>
<td>P. Ermanni, M. Mebolitt, K. Shea</td>
</tr>
<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>6</td>
<td>3V+1U</td>
<td>L. Van Gool, O. Gökser, E. Konukoglu</td>
</tr>
<tr>
<td>227-0523-00L</td>
<td>Railway Systems I</td>
<td>6</td>
<td>4G</td>
<td>M. Meyer</td>
</tr>
</tbody>
</table>
Abstract
Basic characteristics of railway vehicles and their interfaces with the railway infrastructure:
- Transportation tasks and vehicle types
- Running dynamics
- Mechanical part of rail vehicles
- Brakes
- Traction chain and auxiliary supply
- Railway power supply
- Signaling systems
- Traffic control and maintenance

Objective
- Overview of the technical characteristics of railway systems
- Know-how about the design and construction principles of rail vehicles
- Interrelationship between different fields of engineering sciences (mechanics, electro and information technology, transport systems)
- Understanding tasks and opportunities of engineers working in an environment which has strong economical and political boundaries
- Insight into the activities of the railway vehicle industry and railway operators in Switzerland
- Motivation of young engineers to start a career in the railway industry or with railway operators

Content
EST I (Frühjahrsemester) - Begriffen, Grundlagen, Merkmale

1 Einführung:
1.1 Geschichte und Struktur des Bahnsystems
1.2 Fahrdynamik

2 Vollbahnfahrzeuge:
2.3 Mechanik: Kasten, Drehgestelle, Lauftechnik, Adhäsion
2.2 Bremsen
2.3 Traktionsantriebssysteme
2.4 Hilfsbetriebe und Komfortanlagen
2.5 Steuerung und Regelung

3 Infrastruktur:
3.1 Fahrweg
3.2 Bahnstromversorgung
3.3 Sicherungsanlagen

4 Betrieb:
4.1 Interoperabilität, Normen und Zulassung
4.2 RAMS, LCC
4.3 Anwendungsbeispiele

Voraussichtlich ein oder zwei Gastreferate

Geplante Exkursionen:
- Betriebszentrale SBB, Zürich Flughafen
- Reparatur und Unterhalt, SBB Zürich Altstetten
- Fahrzeugfertigung, Stadler Bussnang

Geplante Exkursionen
- Betriebszentrale SBB, Zürich Flughafen
- Reparatur und Unterhalt, SBB Zürich Altstetten
- Fahrzeugfertigung, Stadler Bussnang

252-0535-00L Machine Learning
8 credits
3V+2U+2A
J. M. Buhmann

Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature
Prerequisites / notice

The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.


Abstract

This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.

Objective

At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis. In addition, the course is intended to stimulate the students' curiosity to explore the field of computer graphics in subsequent courses or on their own.

Content

This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.

Lecture notes

no

Prerequisites / notice

Prerequisites:

Fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, programming skills in C++, Visual Computing course recommended.

The programming assignments will be in C++. This will not be taught in the class.

327-0501-00L Metals I W 3 credits 2V+1U R. Spolenak

Abstract

Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

Objective

Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

Content

Dislocation theory:

Properties of dislocations, motion and kinetics of dislocations, dislocation-dislocation and dislocation-boundary interactions, consequences of partial dislocations, sessile dislocations

Hardening theory:

a. solid solution hardening; case studies in copper-nickel and iron-carbon alloys
b. particle hardening: case studies on aluminium-copper alloys

High temperature plasticity:

thermally activated glide
power-law creep
diffusional creep: Coble, Nabarro-Herring
deformation mechanism maps
Case studies in turbine blades
superplastizity
alloying effects

Literature

Gottstein, Physikalische Grundlagen der Materialkunde, Springer Verlag
Haasen, Physikalische Metallkunde, Springer Verlag
Rösler/Harders/Bäker, Mechanisches Verhalten der Werkstoffe, Teubner Verlag
Porter/Easterling, Transformations in Metals and Alloys, Chapman & Hall
Hull/Bacon, Introduction to Dislocations, Butterworth & Heinemann
Courtney, Mechanical Behaviour of Materials, McGraw-Hill

327-4101-00L Durability of Engineering Materials W 2 credits 2G J. Wheeler

Abstract

Basics of fracture mechanics, an engineering discipline that draws upon the principles of applied mechanics and materials science. The course gives the tools to a successful application of fracture mechanics concepts to failure analysis.

Objective

The students should know the possibilities and limitations of the use of standard materials as well as get an idea of new innovative development to prevent failure problems. It is an introduction to the field of fracture mechanics, an engineering discipline that draws upon the principles of applied mechanics and materials science. Cracks and crack-like defects are evaluated with a view to understanding and predicting the cracks' growth tendencies. Such growth may be either stable (relatively slow and safe) or unstable (instantaneous and catastrophic). The course gives the tools to a successful application of fracture mechanics concepts to failure analysis.

Content

Crack-flaws cannot be neglected in engineering analysis. Even micropopcrack flaws can grow over time, ultimately resulting in fractured components. Structures that may have been blindly deemed "safe" could fail disastrously, causing injuries to its users, or the loss of life. Fracture mechanics can be used to:

* Determine how large a crack can be in a structure before it leads to catastrophic failure
* Predict the rate at which a crack can approach a critical size due to fatigue loads or aggressive environmental conditions

The topics covered are

* Introduction to Linear Elastic Fracture Mechanics (LEFM); crack tip stress, strain and displacement fields in linear elastic materials (Modes I, II and III); the stress-intensity factor, K; the fracture toughness KIc and their determination; fracture criterion
* Estimates of crack plastic zones in ductile materials
* The compliance method; experimental determination of compliance
* Introduction to fracture mechanics of nonlinear materials: the J-integral; the JIc fracture criterion; JIc testing
* Application of fracture mechanics concepts in the analysis of subcritical crack growth (fatigue, stress corrosion cracking, creep and their combinations)
* Lifetime determination and prediction; failure analysis.

Lecture notes

Copy of the overheads

Literature

K.H. Schwablae, Bruchmechanik, Carl Hanser Verlag

351-0555-00L Open- and User Innovation W 3 credits 2G S. Häfliger, S. Spaeth

Abstract

The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.
The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management and develop strategies to harness the value of user-developed ideas and contributions for firms and other organizations.

The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.

The course presents and builds upon recent research and challenges the students to devise innovation strategies that take into account the availability of user expertise, free and public knowledge, and the interaction with communities that span beyond one organization.

Grading is based on the final exam, the class presentations (including the slides) as well as class participation.

This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structuration of technology, and an introduction to entrepreneurship.

The slides of the lectures are made available and updated continuously through the SMI website: 

Relevant literature for the exam includes the slides and the reading assignments. The corresponding papers are either available from the author online or distributed during class.

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
<th>Type</th>
<th>Prerequisites / Notice</th>
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<tbody>
<tr>
<td>363-0445-00L</td>
<td>Production and Operations Management</td>
<td>3</td>
<td>W</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>This core course on Production and Operations Management provides the students insights into the basic theories, principles, concepts, and techniques used to design, analyze, and improve the operational capabilities of an organization.</td>
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<td>Objective</td>
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<td>Students learn why and how operations can be a competitive weapon; how to design, plan, control, and manage production and service processes; how to improve effectiveness and efficiency in operations; how to take advantage of new technological advancements; and how environmental and social concerns affect decisions in global production networks.</td>
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<td>Content</td>
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<td>The course covers the most fundamental strategic and tactical concepts in production and operations management. The lectures cover: Introduction to POM; Operations strategy; Capacity management; Production planning and control; Production philosophies; Lean management; Performance measurement; Problem solving; Service operations; New technologies in POM; Servitization; Global production; and Triple-bottom line.</td>
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<tr>
<td></td>
<td>Literature</td>
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<tr>
<td>363-0445-02L</td>
<td>Production and Operations Management</td>
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<td>W</td>
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<td></td>
<td>Abstract</td>
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<td>Extension to course 363-0445-00 Production and Operations Management.</td>
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<td>Objective</td>
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<td>Extension to course 363-0445-00 Production and Operations Management.</td>
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<td>Content</td>
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<td>Additional cases to course 363-0445-00 Production and Operations Management.</td>
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<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>3</td>
<td>W</td>
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<td></td>
<td>Abstract</td>
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<td>Finding solutions: what is complexity, problem solving cycle.</td>
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<td>Implementing solutions: project management, critical path method, quality control feedback loop.</td>
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<td>Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption</td>
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<td>Objective</td>
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<td>A successful participant of the course is able to:</td>
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<td>- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches</td>
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<td>- apply the problem solving cycle as a systematic approach to identify problems and their solutions</td>
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<td>- calculate project schedules according to the critical path method</td>
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<td>- setup and run systems dynamics models by means of the Vensim software</td>
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<td>- identify feedback cycles and reasons for unintended systems behavior</td>
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<td>- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics</td>
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<td>Content</td>
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<td></td>
<td>Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.</td>
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<td>The course is structured along three main tasks:</td>
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<td>1. Finding solutions</td>
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<td>2. Implementing solutions</td>
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<td>3. Controlling solutions</td>
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<td></td>
<td>PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.</td>
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<td>PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.</td>
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<td>PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.</td>
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<td></td>
<td>Lecture notes</td>
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<td></td>
<td>Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.</td>
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<td>Prerequisites / notice</td>
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<td>The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture</td>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
</tr>
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<tbody>
<tr>
<td>363-0711-00L</td>
<td>Accounting for Managers</td>
<td>3</td>
<td>W</td>
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<td>Prerequisites / notice</td>
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<td>Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.</td>
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</tbody>
</table>
Abstract
Overview of financial and managerial accounting
Accounting for current and fixed assets
Liabilities and owners equity
Recording change in balance sheet
Measuring financial performance
Managing financial reporting
Full and variable costing system
Using accounting information for decision making purposes

Objective
Understand the different procedures involved in the accounting system
Record change in financial position
Measure business income
Prepare final accounts
Understand the principles of cost accounting
Calculate the different product costs
Make decisions about the acceptance or rejection of a particular product

Content
Financial Accounting: Balance sheet, income statement, double-entry accounting, journal and ledger, accounting for merchandising activities, value-added tax, adjustments before final accounts, provisions, depreciation, valuation,
Managerial Accounting: Full costing, variable costing, cost-volume profit, break-even analysis, activity-based costing

Prerequisites / notice
This course is a prerequisite for the course Financial Management.

376-1177-00L Human Factors I

Abstract
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people’s satisfaction & overall performance.

Objective
The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry, Digital Human Models
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature
- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students
- Further textbooks are introduced in the lecture
- Brouchures, checklists, key articles etc. are uploaded in ILIAS

376-1219-00L Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions

Abstract
Rehabilitation Engng is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

Content
- Rehabilitation of visual function
  - Anatomy and physiology of the visual sense
  - Technical aids (glasses, sensor substitution)
  - Retina and cortex implants
- Rehabilitation of hearing function
  - Anatomy and physiology of the auditory sense
  - Hearing aids
  - Cochlea Implants
- Rehabilitation and use of kinesthetic and tactile function
  - Anatomy and physiology of the kinesthetic and tactile sense
  - Tactile/haptic displays for motion therapy (incl. electrical stimulation)
  - Role of displays in motor learning
- Rehabilitation of vestibular function
  - Anatomy and physiology of the vestibular sense
  - Rehabilitation strategies and devices (e.g. BrainPort)
- Rehabilitation of vegetative Functions
  - Cardiac Pacemaker
  - Phrenic stimulation, artificial breathing aids
  - Bladder stimulation, artificial sphincter
  - Brain stimulation and recording
  - Deep brain stimulation for patients with Parkinson, epilepsy, depression
  - Brain-Computer Interfaces

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1054 of 1571
Topics covered in this course include:

- A mechanical metamaterial derives its static or dynamic properties not from its microscopic composition but rather through its clever design principles, the students will be able to choose the appropriate approach to create a metamaterial with a pre-defined functionality as the use of Bragg scattering, local resonances, topological band-structures, and non-linear effects.


Selected Journal Articles and Web Links:

- VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html

- Target Group: Students of higher semesters and PhD students of
  - D-MAVT, D-ITET, D-INFK, D-HEST
  - Biomedical Engineering, Robotics, Systems and Control
  - Medical Faculty, University of Zurich
  - Students of other departments, faculties, courses are also welcome

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

401-0647-00L Introduction to Mathematical Optimization W 5 credits 2V+1U D. Adjiashvili

Objective: Introduction to basic techniques and problems in mathematical optimization, and their applications to problems in engineering.

Content: The goal of the course is to obtain a good understanding of some of the most fundamental mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems. The students will also practice applying the learned models to problems in engineering.

Information about relevant literature will be given in the lecture.

402-0801-66L Mechanical Metamaterials W 4 credits 2V+1U S. Huber

Objective: A mechanical metamaterial derives its static or dynamic properties not from its microscopic composition but rather through its clever engineering at larger scales. In this course we introduce the basic principles behind the design of modern mechanical metamaterials such as the use of Bragg scattering, local resonances, topological band-structures, and non-linear effects.

The students should get acquainted with a modern toolbox in the design of mechanical metamaterials. Equipped with the knowledge of the key design principles, the students will be able to choose the appropriate approach to create a metamaterial with a pre-defined functionality either for dynamic applications such as vibration isolation, wave-guiding, or the design of a heat-diode, or static properties such as stress absorption or the design of mechanisms used in robotics.
Content
1.) Wave propagation in continuous systems
2.) Wave properties
3.) Discrete systems
4.) Local resonances
5.) Topology by example
6.) Topological classification
7.) Static systems
8.) Non-linear waves

Lecture notes
Hand-outs will be available in class.

Robotics, Systems and Control

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
151-0104-00L | Uncertainty Quantification for Engineering & Life Sciences | W | 4 credits | 3G | P. Koumoutsakos

Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

151-0107-20L | High Performance Computing for Science and Engineering (HPCSE) I | W | 4 credits | 4G | M. Troyer, P. Chatzidoukas

Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)
Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1...
Class notes, handouts

151-0532-00L | Nonlinear Dynamics and Chaos I | W | 4 credits | 2V+2U | G. Haller, F. Kogelbauer

Abstract
Basic facts about nonlinear systems; stability and near-equilibrium dynamics; bifurcations; dynamical systems on the plane; non-autonomous dynamical systems; chaotic dynamics.

Objective
This course is intended for Masters and Ph.D. students in engineering sciences, physics and applied mathematics who are interested in the behavior of nonlinear dynamical systems. It offers an introduction to the qualitative study of nonlinear physical phenomena modeled by differential equations or discrete maps. We discuss applications in classical mechanics, electrical engineering, fluid mechanics, and biology. A more advanced Part II of this class is offered every other year.

Content
(1) Basic facts about nonlinear systems: Existence, uniqueness, and dependence on initial data.
(2) Near equilibrium dynamics: Linear and Lyapunov stability
(3) Bifurcations of equilibria: Center manifolds, normal forms, and elementary bifurcations
(4) Nonlinear dynamical systems on the plane: Phase plane techniques, limit sets, and limit cycles.
(5) Time-dependent dynamical systems: Floquet theory, Poincare maps, averaging methods, resonance

Lecture notes
The class lecture notes will be posted electronically after each lecture. Students should not rely on these but prepare their own notes during the lecture.

Prerequisites / notice
- Prerequisites: Analysis, linear algebra and a basic course in differential equations.
- Exam: two-hour written exam in English.
- Homework: A homework assignment will be due roughly every other week. Hints to solutions will be posted after the homework due dates.

151-0563-01L | Dynamic Programming and Optimal Control | W | 4 credits | 2V+1U | R. D'Andrea

Abstract
Introduction to Dynamic Programming and Optimal Control.
Covers the fundamental concepts of Dynamic Programming & Optimal Control.
Engine Systems

**Abstract**
Introduction to current and future engine systems and their control systems

**Objective**
Introduction to methods of control and optimization of dynamic systems. Application to real engines. Understand the structure and behavior of drive train systems and their quantitative descriptions.

**Content**
Physical description and mathematical models of components and subsystems (mixture formation, load control, supercharging, emissions, drive train components, etc.). Case studies of model-based optimal design and control of engine systems with the goal of minimizing fuel consumption and emissions.

**Lecture notes**
Introduction to Modeling and Control of Internal Combustion Engine Systems
Guzzella Lino, Onder Christopher H.
ISBN: 978-3-642-10774-0

**Prerequisites / notice**
Combined homework and testbench exercise (air-to-fuel-ratio control or idle-speed control) in groups

Vehicle Propulsion Systems

**Abstract**
Introduction to current and future propulsion systems and the electronic control of their longitudinal behavior

**Objective**
Introduction to methods of system optimization and controller design for vehicles. Understanding the structure and working principles of conventional and new propulsion systems. Quantitative description of propulsion systems.

**Content**
Understanding of physical phenomena and mathematical models of components and subsystems (manual, automatic and continuously variable transmissions, energy storage systems, electric drive trains, batteries, hybrid systems, fuel cells, road/wheel interaction, automatic braking systems, etc.).

**Lecture notes**
Vehicle Propulsion Systems -- Introduction to Modeling and Optimization
Guzzella Lino, Scarretta Antonio
ISBN: 978-3-642-35912-5

**Prerequisites / notice**
Lectures of Dr. Ch. Onder are also possible to be held in German

System Modeling

**Abstract**

**Objective**

**Content**
Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data. Examples: mechatronic, thermodynamic, chemistry, fluid dynamic, energy, and process engineering systems. Model scaling, linearization, order reduction, and balancing. Estimation techniques (least-squares methods). Case class studies: Loud-speaker, Water-propelled rocket, geostationary satellites, etc. The exercises address practical examples. One larger case study is to be solved.

**Lecture notes**
Lectures of Dr. Ch. Onder are also possible to be held in German

**Literature**
The handouts in English will be sold in the first lecture.

A list of references is included in the handouts.

Embedded Control Systems

**Abstract**
This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

**Objective**
Familiarize students with main architectural principles and concepts of embedded control systems.

**Content**
An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch.

Subjects covered in lectures and practical lab exercises include:
- The application of C-programming on a microprocessor
- Digital I/O and serial communication
- Quadrature decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Pulse width modulation
- Timer interrupts to create sampling time intervals
- System dynamics and virtual worlds with haptic feedback
- Introduction to rapid prototyping

**Lecture notes**
Lecture notes, lab instructions, supplemental material

**Prerequisites / notice**
This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: marischm@ethz.ch)

After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

Detailed information can be found on the course website http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html
Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.

Lecture notes available.

The course will be taught in English.

**Objective**

Obtain an overview of various topics in Robotics, Systems, and Controls from leaders in the field. Please see http://rpg.ifi.uzh.ch/teaching.html for a list of upcoming lectures.

**Abstract**

The objective of this course is to expose students to the fundamentals of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

**Content**

Skills for Creativity and Innovation

This lecture aims to enhance the knowledge and competency of students regarding their innovation capability. An overview on prerequisites of and different skills for creativity and innovation in individual & team settings is given. The focus of this lecture is clearly on building competencies - not just acquiring knowledge.

**Objective**

- Basic knowledge about creativity and skills
- Knowledge about individual prerequisites for creativity
- Development of individual skills for creativity
- Knowledge about teams
- Development of team-oriented skills for creativity
- Knowledge and know-how about transfer to idea generation teams

**Prerequisites / notice**

The lecture will be taught in English.
Content

- Basic knowledge about creativity and skills:
  - Introduction into creativity & innovation: definitions and models
- Knowledge about individual prerequisites for creativity:
  - Personality, motivation, intelligence
- Development of individual skills for creativity:
  - Focus on creativity as problem analysis & solving
  - Individual skills in theoretical models
  - Individual competencies: exercises and reflection
- Knowledge about teams:
  - Definitions and models
  - Roles in innovation processes
- Development of team-oriented skills for creativity:
  - Idea generation and development in teams
  - Cooperation & communication in innovation teams
- Knowledge and know-how about transfer to idea generation teams:
  - Self-reflection & development planning
  - Methods of knowledge transfer

Literature

- Slides, script and other documents will be distributed via moodle.ethz.ch

Lecture notes

- Please refer to lecture script.

151-0727-00L Colloquium on Manufacturing Technology

Objective

- Continuous further training to current topics of the manufacturing technique. Exchange of experience and knowledge with the industry and other universities.

Content

- Selected actual topics on manufacturing methods and tools, machine tools, NC-control and drives, components and measuring methods and devices. Topics are changing every year.

Prerequisites / notice

- Students must have participated and passed the courses Manufacturing, Production Machines I and Forming Technology III - Forming Processes.
- Further training with specialized lectures and large participation from the industry.

Language: Help for English speaking students on request.

151-0851-00L Introduction to Aircraft and Car Aerodynamics

Objective

- Using experimental and theoretical methods to illustrate possibilities and limits.
- Illustration of the intrinsic problems and results using examples.
- Configurations of aircraft and car components.
- To understand the basic relations of the origin of aerodynamic forces (e.g., lift, drag). To quantify the aerodynamic forces for basic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

Content

- Introduction to aircraft and car aerodynamics: Atmosphere; aerodynamic forces (lift, drag); thrust.
- Aircraft aerodynamics: Atmosphere; aerodynamic forces (lift, drag); thrust.
- Multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

Prerequisites / notice

- Two tests are offered for practicing the course material. Participation is mandatory.
- Further training with specialized lectures and large participation from the industry.

Language: Help for English speaking students on request.

151-0917-00L Mass Transfer

Objective

- This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Content

- Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

Literature


Prerequisites / notice

- Two tests are offered for practicing the course material. Participation is mandatory.

151-1116-00L Robot Dynamics

Objective

- The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

Language: Help for English speaking students on request.

151-0851-00L Robot Dynamics

Objective

- We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

Content

- The course consists of three parts: First, we will refresh and deepen the student’s knowledge in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

Prerequisites / notice

- No script.

Language: Help for English speaking students on request.

151-0917-00L Mass Transfer

Objective

- This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Content

- This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Prerequisites / notice

- No script.

Language: Help for English speaking students on request.
| Content | Aircraft aerodynamics: atmosphere, aerodynamic forces (ascending force; profile, wings. Resistance, residual resistance, induced resistance); thrust (overview of the propulsion system, aerodynamics of the propellers), introduction to static longitudinal stability. |  |
| Lecture notes | 1.) Grundlagen der Flugtechnik (Basics of flight science, script in german language) 2.) Einführung in die Fahrzeug aerodynamik (Introduction in car aerodynamics, script in german language) |  |

### 227-0225-00L Linear System Theory

| Abstract | The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology. | W 6 credits 5G M. Kamgarpour |
| Objective | By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them. |  |

### 227-0447-00L Image Analysis and Computer Vision

| Objective | Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises. |  |
| Content | The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed. |  |
| Lecture notes | Prerequisites: Control Systems I (227-0103-00) or equivalent and sufficient mathematical maturity. |  |

### 227-0517-00L Electrical Drive Systems II

| Abstract | In the course "Drive System II" the power semiconductors are repeated. The creation of converters based on the combination of switches-cells and basic topologies is explained. Another main focus is on the 3-level inverter with its switching and transfer functions. Further topics are the control of the synchronous machine, of line-side converters and issues with converter-fed machines. | W 6 credits 4G P. Steimer, G. Scheuer, C. A. Stulz |
| Objective | The students establish a deeper understanding in regards of the design of the main components of an electrical drive system. They establish knowledge on the most important interaction with the grid and the machine and their related high dynamic control. |  |
| Content | Converter topologies (switch or cell based), multi-pulse diode rectifiers, system aspects of transformer and electrical machines, 3-level inverter with its switching and transfer functions, grid side harmonics, modeling and control of synchronous machines (including permanent magnet machines), control of line-side converters, reflection effects with power cables, winding isolation and bearing stress. Field trip to ABB Semiconductors. |  |
| Lecture notes | Skript is sold at the beginning of the lectures or can be downloaded from Ilias |  |
| Literature | Skript of lecture; References in skript to related technical publications and books |  |
| Prerequisites / notice | Course material Script, computer demonstrations, exercises and problem solutions |  |

### 227-0689-00L System Identification

| Abstract | Theory and techniques for the identification of dynamic models from experimentally obtained system input-output data. | W 4 credits 2V+1U R. Smith |
| Objective | To provide a series of practical techniques for the development of dynamical models from experimental data, with the emphasis being on the development of models suitable for feedback control design purposes. To provide sufficient theory to enable the practitioner to understand the trade-offs between model accuracy, data quality and data quantity. |  |
| Prerequisites / notice | Prerequisites: Electrical Drive Systems I (recommended), Basics in electrical engineering, power electronics, automation and mechatronics |  |
Rehabilitation Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

### 252-3110-00L Human Computer Interaction

**Objective**

The course provides an introduction to the field of human-computer interaction, emphasising the central role of the user in system design. Through detailed case studies, students will be introduced to different methods used to analyse the user experience and shown how these can inform the design of new interfaces, systems and technologies.

**Content**

The goal of the course is that students should understand the principles of user-centred design and be able to apply these in practice. The course will introduce students to various methods of analysing the user experience, showing how these can be used at different stages of system development from requirements analysis through to usability testing. Students will get experience of designing and carrying out user studies as well as analysing results. The course will also cover the basic principles of interaction design. Practical exercises related to touch and gesture-based interaction will be used to reinforce the concepts introduced in the lecture. To get students to further think beyond traditional system design, we will discuss issues related to ambient information and awareness.

### 263-5210-00L Probabilistic Artificial Intelligence

**Objective**

How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit "intelligent" behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.

**Content**

Topics covered:
- Search (BFS, DFS, A*), constraint satisfaction and optimization
- Tutorial in logic (propositional, first-order)
- Probability
- Bayesian Networks (models, exact and approximative inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
- Probabilistic planning (MDPs, POMDPs)
- Reinforcement learning
- Combining logic and probability
- Search (BFS, DFS, A*)
- Constraint satisfaction and optimization
- Tutorial in logic (propositional, first-order)
- Probability
- Bayesian Networks (models, exact and approximative inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
- Probabilistic planning (MDPs, POMDPs)
- Reinforcement learning
- Combining logic and probability

**Prerequisites / notice**

Solid basic knowledge in statistics, algorithms and programming

### 263-5902-00L Computer Vision

**Objective**

The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

**Content**

- Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

### 376-1219-00L Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions

**Objective**

- Rehabilitation Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.
- Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

**Content**

- Introduction, problem definition, overview
- Rehabilitation of visual function
  - Anatomy and physiology of the visual sense
  - Technical aids (glasses, sensor substitution)
  - Retina and cortex implants
- Rehabilitation of hearing function
  - Anatomy and physiology of the auditory sense
  - Hearing aids
  - Cochlea Implants
- Rehabilitation and use of kinesthetic and tactile function
  - Anatomy and physiology of the kinesthetic and tactile sense
- Rehabilitation of vestibular function
  - Anatomy and physiology of the vestibular sense
  - Rehabilitation strategies and devices (e.g. BrainPort)
- Rehabilitation of vegetative Functions
  - Cardiac Pacemaker
  - Phrenic stimulation, artificial breathing aids
  - Bladder stimulation, artificial sphincter
- Brain stimulation and recording
  - Deep brain stimulation for patients with Parkinson, epilepsy, depression
  - Brain-Computer Interfaces

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation. The lecture is accompanied by practical courses and excursions.

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

### Prerequisites / notice
- Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich
- Students of other departments, faculties, courses are also welcome

### Literature
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

Objective

The objective of this course is to give an introduction to the fundamentals of physical human-robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and de-sign safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical-human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

Content

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical-human-robot interaction, laboratory sessions and lab visits.

Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://www.relab.ethz.ch/education/courses/phri/request-ehz-haptic-paddle-documentation.html), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling regularity, quantization, etc.) during rendering of different mechanical properties.

Lecture notes

Will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/phri.html

Literature


Prerequisites / notice

The course language is English. Basic experience in Information Technology and Computer Science will be of advantage. More details will be announced in the lecture.
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>P. Koumoutsakos</td>
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<td>and Propagation (UQ+P) for computational models of systems in</td>
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<td>relevant algorithms in multicore architectures.</td>
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<td>under parametric and non-parametric modelling uncertainty, Bayesian</td>
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<td>inference with model class assessment, Markov Chain Monte Carlo</td>
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<td>simulation, prior and posterior reliability analysis.</td>
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<td>Bayesian Tutorial by Devinderjit Sivia as well as on class notes</td>
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<td>and related literature that will be distributed in class.</td>
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<td>Fundamentals of Probability, Fundamentals of Computational Modeling</td>
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<td>151-0107-20L</td>
<td>High Performance Computing for Science and Engineering (HPCSE) I</td>
<td>W</td>
<td>4 credits</td>
<td>4G</td>
<td>M. Troyer, P. Chatzidoukas</td>
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<td>Abstract</td>
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<td>This course gives an introduction into algorithms and numerical</td>
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<td>methods for parallel computing for multi and many-core architectures</td>
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<td>and for applications from problems in science and engineering.</td>
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<td>Introduction to HPC for scientists and engineers</td>
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<td>Fundamental of:</td>
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<td>1. Parallel Computing Architectures</td>
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<td>2. MultiCores</td>
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<td>3. ManyCores</td>
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<td>Programming models and languages:</td>
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<td>1. C++ threading (2 weeks)</td>
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<td>2. OpenMP (4 weeks)</td>
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<td>3. MPI (5 weeks)</td>
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<td>Computers and methods:</td>
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<td>1. Hardware and architectures</td>
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<td>3. Particles: N-body solvers</td>
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<td>4. Fields: PDEs</td>
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<td>5. Stochastics: Monte Carlo</td>
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<td>Lecture notes</td>
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<td><a href="http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-">http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-</a></td>
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<td>hpcse1 Class notes, handouts</td>
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<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>B. Nelson</td>
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<td></td>
<td>Abstract</td>
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<td>Microrobotics is an interdisciplinary field that combines aspects of</td>
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<td>robotics, micro and nanotechnology, biomedical engineering, and</td>
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<td>materials science. The aim of this course is to expose students to</td>
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<td>the fundamentals of this emerging field. Throughout the course</td>
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<td>students are expected to submit assignments. The course concludes</td>
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<td>with an end-of-semester examination.</td>
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<td>Objective</td>
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<td>The objective of this course is to expose students to the</td>
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<td>fundamental aspects of the emerging field of microrobotics.</td>
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<td>This includes a focus on physical laws that predominate at the</td>
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<td>microscale, technologies for fabricating small devices, bio-inspired</td>
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<td>design, and applications of the field.</td>
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<td>Content</td>
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<td>Main topics of the course include:</td>
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<td>- Scaling laws at micro/nano scales</td>
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<td>- Electrostatics</td>
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<td>- Electromagnetism</td>
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<td>- Low Reynolds number flows</td>
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<td>- Observation tools</td>
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<td>- Materials and fabrication methods</td>
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<td>- Applications of biomedical microrobots</td>
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<td>Lecture notes</td>
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<td>The powerpoint slides presented in the lectures will be made</td>
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<td>available in hardcopy and as pdf files. Several readings will also</td>
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<td>be made available electronically.</td>
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<td>The lecture will be taught in English.</td>
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<td>151-0605-00L</td>
<td>Nanosystems</td>
<td>W</td>
<td>4 credits</td>
<td>4G</td>
<td>A. Stemmer, J.N. Tisserant</td>
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<td>Abstract</td>
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<td>From atoms to molecules to condensed matter: characteristic</td>
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<td>properties of simple nanosystems and how they evolve when moving</td>
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<td>towards complex ensembles.</td>
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<td>Intermolecular forces, their macroscopic manifestations, and ways</td>
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<td>to control such interactions.</td>
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<td>Self-assembly and directed assembly of 2D and 3D structures.</td>
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<td>Special emphasis on the emerging field of molecular electronic</td>
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<td>devices.</td>
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<td></td>
<td>Familiarize students with basic science and engineering principles</td>
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<td>governing the nano domain.</td>
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</table>
The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

Special emphasis is placed on the emerging field of molecular electronic devices, their working principles, applications, and how they may be assembled.

Topics are treated in 2 blocks:

(I) From Quantum to Continuum
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale
Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.

Self-assembly and directed assembly of 2D and 3D structures.

Literature

Prerequisites / notice
Course format:
Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

- Written documentation and evaluation of the entire production, processing and characterization
- Testing and characterization of the MEMS device
- Packaging and electrical connection of a MEMS device
- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Testing and characterization of the MEMS device
- Written documentation and evaluation of the entire production, processing and characterization

Homework: Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.


151-0620-00L Embedded MEMS Lab

Objective
Practical course: Students are introduced to the process steps required for the fabrication of MEMS (Micro Electro Mechanical System) and carry out the fabrication and testing steps in the clean rooms by themselves. Additionally, they learn the requirements for working in clean rooms. Processing and characterization will be documented and analyzed in a final report. Limited access to laboratory and clean rooms is granted for bachelor and master students, who have started already with it. Respectively, current examples in the research will be discussed.

Participating students are required to attend all scheduled lectures and meetings of the course.

Content
With guidance from a tutor, the individual silicon microsystem process steps that are required for the fabrication of an accelerator are carried out:

- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Packaging and electrical connection of a MEMS device
- Testing and characterization of the MEMS device
- Written documentation and evaluation of the entire production, processing and characterization

Participating students are required to provide proof that they have personal accident insurance prior to the start of the laboratory portion of the course.

If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

Priority 1: master students of the master's program in "Micro and Nanosystems"
Priority 2: master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering (MAVT-tutors Profs Daraio, Dual, Hierold, Koumoutsakos, Nelson, Norris, Park, Poulikakos, Pratsinis, Stemmer), who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.
Priority 3: master students, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.
Priority 4: all other students (PhD, bachelor, master) with a background in silicon or microsystems process technology.

If there are more students in one of these priority groups than places available, we will decide by drawing lots.

Students will be notified at the first lecture of the course (introductory lecture) as to whether they are able to participate.

The course is offered in autumn and spring semester.

151-0621-00L Seminar on Micro and Nanosystems

Objective
In particular, the seminar addresses students, who are interested in scientific work in the field of Micro- and Nanosystem technologies, or who have started already with it. Respectively, current examples in the research will be discussed.

Content
Scientific presentations from the field of Micro- and Nanosystems

Lecture notes
- -

Prerequisites / notice
Master of MNS, MAVT, ITET, Physics

151-0911-00L Introduction to Plasmonics

Abstract
This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.

Course format:


Self-assembly and directed assembly of 2D and 3D structures.

Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.

(II) Interaction Forces on the Micro and Nano Scale
Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.

Self-assembly and directed assembly of 2D and 3D structures.

- written documentation and evaluation of the entire production, processing and characterization
- testing and characterization of the MEMS device
- packaging and electrical connection of a MEMS device
- photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- written documentation and evaluation of the entire production, processing and characterization

With guidance from a tutor, the individual silicon microsystem process steps that are required for the fabrication of an accelerator are carried out:

- photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- packaging and electrical connection of a MEMS device
- testing and characterization of the MEMS device
- written documentation and evaluation of the entire production, processing and characterization
Physics of Failure and Failure Analysis of Electronic

The goal of the lecture is to convey a basic knowledge in the area of FV materials as well as their construction and production processes. Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetimes of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

**Objective**

- Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

- Fundamentals of Plasmonics
  - Basic electromagnetic theory
  - Optical properties of metals
  - Surface plasmon polaritons on surfaces
  - Surface plasmon polariton propagation
  - Localized surface plasmons

- Applications of Plasmonics
  - Waveguides
  - Extraordinary optical transmission
  - Enhanced spectroscopy
  - Sensing
  - Metamaterials

Lecture notes

- Class notes and handouts

Literature


**Prerequisites / notice**

- Two tests are offered for practicing the course material. Participation is mandatory.

**151-0917-00L Mass Transfer**

**Abstract**

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Objective**

- This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Content**

- Fick's laws: application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogeneous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

**Literature**


**Prerequisites / notice**

- Two tests are offered for practicing the course material. Participation is mandatory.

**151-0931-00L Seminar on Particle Technology**

**Abstract**

The goal of the lecture is to convey a basic knowledge in the area of FV materials as well as their construction and production processes and to empower the students to apply the knowledge gained to address current problems in research and practice.

**Objective**

- Students attend and give research presentations for the research they plan to do and at the end of the semester they defend their results and answer questions from research scientists. Familiarize the students with the latest in this field.

**Content**

- Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.

**Literature**

- Class notes and handouts

**Prerequisites / notice**

- Comprehensive copy of transparencies

**227-0377-00L Physics of Failure and Failure Analysis of Electronic Devices and Equipment**

**Abstract**

 Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

**Objective**

- Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.

**Content**

- Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis

**227-0455-00L Terahertz: Technology & Applications**

**Abstract**

This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting.

**Objective**

- This is an introductory course on Terahertz (THz) technology and applications. Devices operating in THz frequency range (0.1 to 10 THz) have been increasingly studied in the recent years. Progress in nonlinear optical materials, ultrafast optical and electronic techniques has strengthened research in THz application developments. Due to unique interaction of THz waves with materials, applications with new capabilities can be developed. In theory, they can penetrate somewhat like X-rays, but are not considered harmful radiation, because THz energy level is low. They should be able to provide resolution as good or better than magnetic resonance imaging (MRI), possibly with simpler equipment. Imaging, very-high bandwidth communication, and energy harvesting are the most widely explored THz application areas. We will study the basics of THz generation, manipulation, and detection. Our emphasis will be on the physical principles and applications of THz in the domain of imaging, communication and energy harvesting.

**Content**

- INTRODUCTION
  - Chapter 1: Introduction to THz Physics
  - Chapter 2: Components of THz Technology
    - THz TECHNOLOGY MODULES
      - Chapter 3: THz Generation
      - Chapter 4: THz Detection
      - Chapter 5: THz Manipulation
    - APPLICATIONS
      - Chapter 6: THz Imaging
      - Chapter 7: THz Communication
      - Chapter 8: THz Energy Harvesting
The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modeling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.


Prerequisites / notice Fundamentals of Probability, Fundamentals of Computational Modeling

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<th>Hours</th>
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<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>P. Koumoutsakos</td>
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<td><em>Number of participants limited to 60.</em></td>
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<td>Abstract</td>
<td>Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.</td>
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<td>Objective</td>
<td>The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.</td>
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<td>High Performance Computing for Science and Engineering (HPCSE) I</td>
<td>W</td>
<td>4 credits</td>
<td>4G</td>
<td>M. Troyer, P. Chatzidoukas</td>
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<tr>
<td></td>
<td><em>Introduction to HPC for scientists and engineers</em></td>
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<tr>
<td>Abstract</td>
<td>Introduction to HPC for scientists and engineers</td>
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<tr>
<td>Objective</td>
<td>Fundamental of:</td>
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<tr>
<td></td>
<td>1. Parallel Computing Architectures</td>
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<td></td>
<td>2. MultiCores</td>
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<td>3. ManyCores</td>
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<tr>
<td>Content</td>
<td>Programming models and languages:</td>
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<tr>
<td></td>
<td>1. C++ threading (2 weeks)</td>
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<td></td>
<td>2. OpenMP (4 weeks)</td>
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<td></td>
<td>3. MPI (5 weeks)</td>
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<tr>
<td>Lecture notes</td>
<td><a href="http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1">http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1</a></td>
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<tr>
<td>Literature</td>
<td>Class notes, handouts</td>
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
<tr>
<td>Abstract</td>
<td>Theory and application of thermodynamics and energy conversion in biological systems with focus on the cellular level.</td>
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<tr>
<td>Objective</td>
<td>Theory and application of energy conversion at the cellular level. Understanding of the basic features governing solutes transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes in the cell, generation of forces, work and relation to biomedical technologies.</td>
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<tr>
<td>Content</td>
<td>Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.</td>
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<tr>
<td>Lecture notes</td>
<td>Material in the form of hand-outs will be distributed.</td>
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<tr>
<td>Literature</td>
<td>Lecture notes and references therein.</td>
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</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0317-00L</td>
<td>Visualization, Simulation and Interaction - Virtual Reality II</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Kunz</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture provides deeper knowledge on the possible applications of virtual reality, its basic technology, and future research fields. The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes.</td>
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<tr>
<td>Objective</td>
<td>Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems. The goal of the lecture is to provide a deeper knowledge of today's VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.</td>
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<tr>
<td>Content</td>
<td>Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of simulation; compression procedures of image-, audio-, and video signals; new materials for force feedback devices; introduction into data security; cryptography; definition of free-form surfaces; digital factory; new research fields of virtual reality</td>
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<tr>
<td>Lecture notes</td>
<td>The handout is available in German and English.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>&quot;Visualization, Simulation and Interaction - Virtual Reality I&quot; is recommended.</td>
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</tbody>
</table>

Didactical concept: The course consists of lectures and exercises.
### 151-0917-00L  
**Mass Transfer**  

**W** 4 credits 2V+2U  R. Büchel, S. E. Pratsinis  

**Abstract**  
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Objective**  
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Content**  
Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

**Literature**  

**Prerequisites / notice**  
Two tests are offered for practicing the course material. Participation is mandatory.

### 151-3205-00L  
**Experimental Ergonomics**  

W 4 credits 2V+2A  J. Held  

**Abstract**  
You will learn how to apply the scientific discipline of ergonomics for system analysis and product development “in order to optimise human well-being and overall system performance” (www.iea.cc). The course offers the framework of models, concepts, methods and tools of applied ergonomics. Teaching is combined with learning-by-doing and research-based learning.

**Objective**  
Knowledge of:
- Principles and rules of applied ergonomic system and product design.
- Methods and tools of ergonomic analysis and evaluation.
- Practical experiences and hands-on skills in:
  - Conducting a study in system and task analysis.
  - Analysing human-product interactions.
  - Applying ergonomic knowledge for product and system improvements.

**Content**  
- Definition and role of applied ergonomics in engineering and design.
- Framework of ergonomic analysis and design.
- Design principles and rules.
- Methods and tools for system and task analysis.
- Hands-on experience in team work:
  - Experimental study of human-product interaction and usability through eye-tracking
  - Field study of system and task analysis, including on-site visits of complex work stations (Hospital OR/ICU or Air traffic/Railway Control Rooms).

**Lecture notes**  
Handout at the start of the course.

**Literature**  


http://www.baua.de/de/Publikationen/Fachbeitraege/F1902.pdf


**Prerequisites / notice**  
Max. number of participants is 15.

Experiments and field studies in teams of 2-3 students are obligatory.

### 227-0385-10L  
**Biomedical Imaging**  

W 6 credits 5G  S. Kozerke, K. P. Prüssmann, M. Rudin  

**Abstract**  
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

**Objective**  
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

**Content**  
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

**Lecture notes**  
Lecture notes and handouts

**Literature**  
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

### 227-0386-00L  
**Biomedical Engineering**  

W 4 credits 3G  J. Våröös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong  

**Abstract**  
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

**Objective**  
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

**Content**  
<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino AND</th>
</tr>
</thead>
<tbody>
<tr>
<td>URL</td>
<td><a href="https://www1.ethz.ch/lbb/Education/BME">https://www1.ethz.ch/lbb/Education/BME</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Course</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0393-00L</td>
<td>Bioelectronics and Biosensors</td>
<td>2V</td>
<td>J. Vörös, M. F. Yanik, T. Zambelli</td>
<td></td>
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</tbody>
</table>

**Abstract**
The course introduces the concepts of bioelectricity and biosensing. The sources and use of electrical fields and currents in the context of biological systems and problems are discussed. The fundamental challenges of measuring biological signals are introduced. The most important biosensing techniques and their physical concepts are introduced in a quantitative fashion.

**Objective**
During this course the students will:
- learn the basic concepts in biosensing and bioelectronics
- be able to solve typical problems in biosensing and bioelectronics
- learn about the remaining challenges in this field

**Content**

<table>
<thead>
<tr>
<th>L1.</th>
<th>Bioelectronics history, its applications and overview of the field</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Volta and Galvaní dispute</td>
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<td></td>
<td>- BMI, pacemaker, cochlear implant, retinal implant, limb replacement devices</td>
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<tr>
<td></td>
<td>- Fundamentals of biosensing</td>
</tr>
<tr>
<td></td>
<td>- Glucometer and ELISA</td>
</tr>
</tbody>
</table>

| L2. | Fundamentals of quantum and classical noise in measuring biological signals |

<table>
<thead>
<tr>
<th>L3.</th>
<th>Biomeasurement techniques with photons</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>L4.</th>
<th>Acoustics sensors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Differential equation for quartz crystal resonance</td>
</tr>
<tr>
<td></td>
<td>- Acoustic sensors and their applications</td>
</tr>
</tbody>
</table>

| L5. | Engineering principles of optical probes for measuring and manipulating molecular and cellular processes |

<table>
<thead>
<tr>
<th>L6.</th>
<th>Optical biosensors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Differential equation for optical waveguides</td>
</tr>
<tr>
<td></td>
<td>- Optical sensors and their applications</td>
</tr>
<tr>
<td></td>
<td>- Plasmonic sensing</td>
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<table>
<thead>
<tr>
<th>L7.</th>
<th>Basic notions of molecular adsorption and electron transfer</th>
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<tbody>
<tr>
<td></td>
<td>- Quantum mechanics: Schrödinger equation energy levels from H atom to crystals, energy bands</td>
</tr>
<tr>
<td></td>
<td>- Electron transfer: Marcus theory, Gerischer theory</td>
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</tbody>
</table>

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<thead>
<tr>
<th>L8.</th>
<th>Potentiometric sensors</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>- Fundamentals of the electrochemical cell at equilibrium (Nernst equation)</td>
</tr>
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<td></td>
<td>- Principles of operation of ion-selective electrodes</td>
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<table>
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<tr>
<th>L9.</th>
<th>Amperometric sensors and bioelectric potentials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Fundamentals of the electrochemical cell with an applied overpotential to generate a faraday current</td>
</tr>
<tr>
<td></td>
<td>- Principles of operation of amperometric sensors</td>
</tr>
<tr>
<td></td>
<td>- Ion flow through a membrane (Fick equation, Nernst equation, Donnan equilibrium, Goldman equation)</td>
</tr>
</tbody>
</table>

| L10. | Channels, amplification, signal gating, and patch clamp Y4 |

| L11. | Action potentials and impulse propagation |

<table>
<thead>
<tr>
<th>L12.</th>
<th>Functional electric stimulation and recording</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- MEA and CMOS based recording</td>
</tr>
<tr>
<td></td>
<td>- Applying potential in liquid - simulation of fields and relevance to electric stimulation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>L13.</th>
<th>Neural networks memory and learning</th>
</tr>
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<table>
<thead>
<tr>
<th>Literature</th>
<th>Pionsley and Barr, Bioelectricity: A Quantitative Approach (Third edition)</th>
</tr>
</thead>
</table>

| Prerequisites / notice | Supervised exercises solving real-world problems. Some Matlab based exercises in groups. |

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Course</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>3V+1U</td>
<td>L. Van Gool, O. Göksel, E. Konukoglu</td>
<td></td>
</tr>
</tbody>
</table>

**Abstract**

**Objective**
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

**Content**
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Course material Script, computer demonstrations, exercises and problem solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisites / notice</td>
<td>Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.</td>
</tr>
</tbody>
</table>

| 227-0455-00L | Terahertz: Technology & Applications | 3V | K. Sankaran |
This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting.

**Objective**
This is an introductory course on Terahertz (THz) technology and applications. Devices operating in THz frequency range (0.1 to 10 THz) have been increasingly studied in the recent years. Progress in nonlinear optical materials, ultrafast optical and electronic techniques has strengthened research in THz application developments. Due to unique interaction of THz waves with materials, applications with new capabilities can be developed. In theory, they can penetrate somewhat like X-rays, but are not considered harmful radiation, because THz energy level is low. They should be able to provide resolution as good or better than magnetic resonance imaging (MRI), possibly with simpler equipment. Imaging, very-high bandwidth communication, and energy harvesting are the most widely explored THz application areas. We will study the basics of THz generation, manipulation, and detection. Our emphasis will be on the physical principles and applications of THz in the domain of imaging, communication and energy harvesting.

**Content**
INTRODUCTION
Chapter 1: Introduction to THz Physics
Chapter 2: Components of THz Technology

THz TECHNOLOGY MODULES
Chapter 3: THz Generation
Chapter 4: THz Detection
Chapter 5: THz Manipulation

APPLICATIONS
Chapter 6: THz Imaging
Chapter 7: THz Communication
Chapter 8: THz Energy Harvesting

**Literature**
- Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009

Whenever we deviate from the main material discussed in these books, softcopy of lectures notes will be provided.

**Prerequisites / notice**
Good foundation in electromagnetics & knowledge of microwave or optical communication is helpful.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>W</th>
<th>3 credits</th>
<th>2G+2A</th>
<th>C. Frei</th>
</tr>
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<tbody>
<tr>
<td>227-0945-00L</td>
<td>Cell and Molecular Biology for Engineers I</td>
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<tr>
<td>Abstract</td>
<td>This course is part I of a two-semester course.</td>
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<tr>
<td>Objective</td>
<td>The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.</td>
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<tr>
<td>Content</td>
<td>After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.</td>
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<tr>
<td>Literature</td>
<td>Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.</td>
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<tr>
<td>In addition, three journal clubs will be held, where one/two publications will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.</td>
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<tr>
<td>Lecture notes</td>
<td>Scripts of all lectures will be available.</td>
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<tr>
<th>Code</th>
<th>Title</th>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>M. Stampanoni, P. A. Kaestner</th>
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</thead>
<tbody>
<tr>
<td>227-0965-00L</td>
<td>Micro and Nano-Tomography of Biological Tissues</td>
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<tr>
<td>Abstract</td>
<td>The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.</td>
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<tr>
<td>Objective</td>
<td>Introduction to the basic concepts of X-ray tomographic imaging, Image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications</td>
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<tr>
<td>Content</td>
<td>Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.</td>
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<tr>
<td>Lecture notes</td>
<td>The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.</td>
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<tr>
<td>Literature</td>
<td>The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.</td>
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<tr>
<td>Literature</td>
<td>Available online</td>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>W</th>
<th>4 credits</th>
<th>2V+2A</th>
<th>V. Kurtcuoglu, D. de Julien de Zellicourt, M. Meboldt, M. Schmid Daners, O. Ulrich</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0981-00L</td>
<td>Cross-Disciplinary Research and Development in Medicine and Engineering</td>
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<tr>
<td>Abstract</td>
<td>A maximum of 12 medical degree students and 12 (biomedical) engineering degree students can be admitted, their number should be equal.</td>
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<tr>
<td>Objective</td>
<td>Cross-disciplinary collaboration between engineers and medical doctors is indispensable for innovation in health care. This course will bring together engineering students from ETH Zurich and medical students from the University of Zurich to experience the rewards and challenges of such interdisciplinary work in a project based learning environment.</td>
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<tr>
<td>Notice</td>
<td>The main goal of this course is to demonstrate the differences in communication between the fields of medicine and engineering. Since such differences become the most evident during actual collaborative work, the course is based on a current project in physiology research that combines medicine and engineering. For the engineering students, the specific aims of the course are to:</td>
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<tr>
<td>- Acquire a working understanding of the anatomy and physiology of the investigated system;</td>
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<tr>
<td>- Identify the engineering challenges in the project and communicate them to the medical students;</td>
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<td>- Develop and implement, together with the medical students, solution strategies for the identified challenges;</td>
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<td>- Present the found solutions to a cross-disciplinary audience.</td>
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</table>
After a general introduction to interdisciplinary communication and detailed background on the collaborative project, the engineering students will receive tailored lectures on the anatomy and physiology of the relevant system. They will then team up with medical students who have received a basic introduction to engineering methodology to collaborate on said project. In the process, they will be coached both by lecturers from ETH Zurich and the University of Zurich, receiving lectures customized to the project. The course will end with each team presenting their solution to a cross-disciplinary audience.

Handouts and relevant literature will be provided.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1177-00L</td>
<td>Human Factors I</td>
<td>W 2</td>
<td>M. Menozzi Jäckli, R. Huang, M. Siegrist</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Every day humans interact with various systems. Strategies of interaction, individual needs, physical &amp; mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction &amp; overall performance.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.</td>
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<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>- Physiological, physical, and cognitive factors in sensation and perception</td>
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<td></td>
<td>- Body spaces and functional anthropometry, Digital Human Models</td>
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<td></td>
<td>- Experimental techniques in assessing human performance and well-being</td>
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<td></td>
<td>- Human factors and ergonomics in system designs, product development and innovation</td>
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<td></td>
<td>- Human information processing and biological cybernetics</td>
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<td></td>
<td>- Interaction among consumers, environments, behavior, and tasks</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<td></td>
<td>- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students</td>
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<td></td>
<td>- Further textbooks are introduced in the lecture</td>
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<td></td>
<td>- Brouchures, checklists, key articles etc. are uploaded in ILIAS</td>
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<tr>
<td>376-1219-00L</td>
<td>Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions</td>
<td>W 3</td>
<td>R. Riener, R. Gassert, L. Marchal Crespo</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Rehabilitation Engng is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.</td>
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<td></td>
<td><strong>This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.</strong></td>
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<td></td>
<td><strong>Content</strong></td>
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<td></td>
<td>Introduction, problem definition, overview</td>
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<td></td>
<td>Rehabilitation of visual function</td>
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<td></td>
<td>- Anatomy and physiology of the visual sense</td>
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<td></td>
<td>- Technical aids (glasses, sensor substitution)</td>
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<td></td>
<td>- Retina and cortex implants</td>
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<td>Rehabilitation of hearing function</td>
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<td></td>
<td>- Anatomy and physiology of the auditory sense</td>
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<td></td>
<td>- Hearing aids</td>
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<td></td>
<td>- Cochlea Implants</td>
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<td></td>
<td>Rehabilitation and use of kinesthetic and tactile function</td>
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<tr>
<td></td>
<td>- Anatomy and physiology of the kinesthetic and tactile sense</td>
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<td></td>
<td>- Tactile/haptic displays for motion therapy (incl. electrical stimulation)</td>
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<td>- Role of displays in motor learning</td>
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<td></td>
<td>Rehabilitation of vestibular function</td>
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<tr>
<td></td>
<td>- Anatomy and physiology of the vestibular sense</td>
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<tr>
<td></td>
<td>- Rehabilitation strategies and devices (e.g. BrainPort)</td>
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<tr>
<td></td>
<td>Rehabilitation of vegetative Functions</td>
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<tr>
<td></td>
<td>- Cardiac Pacemaker</td>
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<td>- Phrenic stimulation, artificial breathing aids</td>
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<td>- Bladder stimulation, artificial sphincter</td>
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<td></td>
<td>- Brain stimulation and recording</td>
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<tr>
<td></td>
<td>- Deep brain stimulation for patients with Parkinson, epilepsy, depression</td>
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<td></td>
<td>- Brain-Computer Interfaces</td>
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</tbody>
</table>
Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient.

This lecture will derive the technical principles of multi-modal Virtual Reality in Medicine.

Selected Journal Articles and Web Links:


VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html

Prerequisites / notice

Target Group: Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich
- Students of other departments, faculties, courses are also welcome

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

376-1279-00L Virtual Reality in Medicine n  W  3 credits  2V R. Riener

Abstract

Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (audiovisual, haptic, tactile etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Objective

Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation.

Content

Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Target Group:

Students of higher semesters and PhD students of
- D-HEST, D-MAVT, D-ITET, D-INFK, D-PHYS
- Robotics, Systems and Control Master
- Biomedical Engineering/Movement Science and Sport
- Medical Faculty, University of Zurich
- Students of other departments, faculties, courses are also welcome!

Literature

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical-human-robot interaction, laboratory sessions and lab visits. Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://www.relab.ethz.ch/education/courses/phri/request-ethz-haptic-paddle-hardware-documentation.html), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rates, quantization, etc.) during rendering of different mechanical properties.

Lecture notes
Will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/phri.html

Literature

Prerequisites / notice
The course language is English.
Basic experience in Information Technology and Computer Science will be of advantage.
More details will be announced in the lecture.
Measurement and modeling of the human movement during daily activities and in a clinical environment.

The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.

This course includes study design, measurement techniques, clinical testing, accessing movement data and analysis as well as modeling with regards to human movement.

### 376-1714-00L Biocompatible Materials

**Abstract**

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

**Objective**

The class consists of three parts:

1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

**Content**

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

**Recommended supplementary literature** (review articles and selected primary literature) will be provided during the course.

Lecture notes

Handouts can be accessed online.

Lecture notes

Handouts provided during the classes and references therein.

### 376-1985-00L Trauma Biomechanics

**Abstract**

Trauma biomechanics is an interdisciplinary research field investigating the biomechanics of injuries and related subjects such as prevention. The lecture provides an introduction to the basic principles of trauma biomechanics.

**Objective**

Introduction to the basic principles of trauma biomechanics.

**Content**

This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact biomechanics, which uses the combination of fundamental engineering principles and advanced medical technologies to develop injury prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite element modelling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real world examples mainly from automobile safety are used to augment lecture material.

**Literature**

Handouts will be made available.


### 402-0341-00L Medical Physics I

**Abstract**

Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of protection radiation in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

**Objective**

Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefit of patients and the society.

**Content**

The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the excercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

**Lecture notes**

A script will be provided.

### 551-0319-00L Cellular Biochemistry (Part I)

**Abstract**

Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

**Objective**

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

**Content**

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

**Lecture notes**

Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

**Literature**

Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.
### Design, Computation, Product Development & Manufacturing

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Koumoutsakos</td>
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<tr>
<td></td>
<td>Sciences Number of participants limited to 60.</td>
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<td><strong>Abstract</strong></td>
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<td>Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multilore architectures.</td>
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<td></td>
<td><strong>Content</strong></td>
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<td>Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.</td>
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<td><strong>Lecture notes</strong></td>
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<td>The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<tr>
<td></td>
<td>1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia</td>
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<td></td>
<td>2. Probability Theory: The Logic of Science by E. T. Jaynes</td>
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<td></td>
<td>3. Class Notes</td>
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<td><strong>Prerequisites / notice</strong></td>
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<tr>
<td></td>
<td>Fundamentals of Probability, Fundamentals of Computational Modeling</td>
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<td>151-0735-00L</td>
<td>Dynamic Behavior of Materials and Structures</td>
<td>W</td>
<td>4</td>
<td>2V+2U</td>
<td>D. Mohr</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme loadings during manufacturing, crash, impact and blast events.</td>
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<td><strong>Objective</strong></td>
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<td>Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering.</td>
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<td></td>
<td><strong>Content</strong></td>
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<td>Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td>Slides of the lectures, relevant journal papers and users manuals will be provided.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<td>Various books will be recommended covering the topics discussed in class</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Course in continuum mechanics (mandatory), finite element method (recommended)</td>
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<tr>
<td>151-3205-00L</td>
<td>Experimental Ergonomics</td>
<td>W</td>
<td>4</td>
<td>2V+2A</td>
<td>J. Held</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>You will learn how to apply the scientific discipline of ergonomics for system analysis and product development &quot;in order to optimise human well-being and overall system performance&quot; (<a href="http://www.iea.cc">www.iea.cc</a>). The course offers the framework of models, concepts, methods and tools of applied ergonomics. Teaching is combined with learning-by-doing and research-based learning.</td>
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<td><strong>Objective</strong></td>
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<td>Knowledge of:</td>
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<td></td>
<td>- Principles and rules of applied ergonomics product and system design.</td>
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<td></td>
<td>- Methods and tools of ergonomic analysis and evaluation.</td>
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<td>Practical experiences and hands-on skills in:</td>
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<td></td>
<td>- Conducting a study in system and task analysis.</td>
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<td></td>
<td>- Analysing human-product interactions.</td>
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<td></td>
<td>- Applying ergonomic knowledge for product and system improvements.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>- Definition and role of applied ergonomics in engineering and design.</td>
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<tr>
<td></td>
<td>- Framework of ergonomic analysis and design.</td>
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<td>- Design principles and rules.</td>
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<td></td>
<td>- Methods and tools for system and task analysis.</td>
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<td></td>
<td>- Hands-on experience in team work:</td>
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<td></td>
<td>- Experimental study of human-product interaction and usability through eye-tracking</td>
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<td></td>
<td>- Field study of system and task analysis, including on-site visits of complex work stations (Hospital OR/ICU or Air traffic/Railway Control Rooms).</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td>Handout at the start of the course.</td>
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<td></td>
<td><strong>Literature</strong></td>
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<td><a href="http://www.baua.de/Publikationen/Fachbeitrage/F1902.pdf">http://www.baua.de/Publikationen/Fachbeitrage/F1902.pdf</a></td>
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<td></td>
<td><strong>Prerequisites / notice</strong></td>
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<tr>
<td></td>
<td>Max. number of participants is 15. Experiments and field studies in teams of 2-3 students are obligatory.</td>
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<tr>
<td>151-3209-00L</td>
<td>Engineering Design Optimization</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>K. Shea, T. Stankovic</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>The course covers fundamentals of computational optimization methods in the context of engineering design. It develops skills to formally state and model engineering design tasks as optimization problems and select appropriate methods to solve them.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>The lecture and exercises teach the fundamentals of optimization methods in the context of engineering design. After taking the course students will be able to express engineering design problems as formal optimization problems. Students will also be able to select and apply a suitable optimization method given the nature of the optimization model. They will understand the links between optimization and engineering design in order to design more efficient and performance optimized technical products. The exercises are MATLAB based.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
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<td></td>
<td>available on Moodle</td>
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<tr>
<td>363-1065-00L</td>
<td>Design Thinking: Human-Centred Solutions to Real</td>
<td>W</td>
<td>5</td>
<td>5G</td>
<td>A. Cabello Llamas, F. Rittiner</td>
</tr>
</tbody>
</table>
The semester project is designed to train students in the solution of specific engineering problems. Following a Design Thinking approach, students will learn how to observe and interact with key stakeholders in order to develop an in-depth understanding of what is truly important and emotionally meaningful to the people at the center of a problem. Based on these insights, the students ideate on possible solutions and immediately validated them through quick iterations of prototyping and testing using different tools and materials. The students will work in multidisciplinary teams on a set of challenges that are organized as a one-week, a three-week, and a final six-week project with an external project partner. In this course, the students will learn about the different Design Thinking methods and tools that are needed to generate deep insights, to engage in collaborative ideation, rapid prototyping and iterative testing. Design Thinking is a deeply human process that taps into the creative abilities we all have, but that get often overlooked by more conventional problem solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as functional, and to express ourselves through means beyond words or symbols. Design Thinking provides an integrated way by incorporating tools, processes and techniques from design, engineering, the humanities and social sciences to identify, define and address diverse challenges. This integration leads to a highly productive collaboration between different disciplines.

For more information and the application visit: http://sparklabs.ch/ethz

Prerequisites / notice
Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

**Multidisciplinary Courses**

The students are free to choose individually from the entire course offer of ETH Zurich, ETH Lausanne and the Universities of Zurich and St. Gallen.

**Course Catalogue of ETH Zurich**

### Semester Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1002-00L</td>
<td>Semester Project Mechanical Engineering Only for Mechanical Engineering MSc.</td>
<td>O</td>
<td>8 credits</td>
<td>17A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

**Abstract**

The semester project is designed to train students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

**Objective**

The semester project is designed to train students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program.

### Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1003-00L</td>
<td>Industrial Internship Mechanical Engineering</td>
<td>O</td>
<td>8 credits</td>
<td>external organisers</td>
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</tr>
</tbody>
</table>

**Abstract**

The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

**Objective**

The main objective of the 12-week internship is to expose master's students to the industrial work environment.

### GESS Science in Perspective

- see GESS Science in Perspective: Type A: Enhancement of Reflection Capability
- see GESS Science in Perspective: Language Courses ETH/ÜZH
- Recommended GESS Science in Perspective (Type B) for D-MAVT.

### Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1001-00L</td>
<td>Master's Thesis Mechanical Engineering</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Students who fulfill the following criteria are allowed to begin with their Master's Thesis:
- a. successful completion of the bachelor program;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme;
- c. successful completion of the semester project and
The Master's Thesis must be approved in advance by the tutor and is supervised by a professor of ETH Zurich. To choose a titular professor as a supervisor, please contact the D-MAVT Student Administration.

Abstract
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

Course Units for Additional Admission Requirements
The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0173-AAL</td>
<td>Linear Algebra I and II</td>
<td>E-</td>
<td>6 credits</td>
<td>13R</td>
<td>N. Hungerbühler</td>
</tr>
</tbody>
</table>

Abstract
Linear algebra is an indispensable tool of engineering mathematics. The course is an introduction to basic methods and fundamental concepts of linear algebra and its applications to engineering sciences.

Objective
After completion of this course, students are able to recognize linear structures and to apply adequate tools from linear algebra in order to solve corresponding problems from theory and applications. In addition, students have a basic knowledge of the software package Matlab.

Content
Systems of linear equations, Gaussian elimination, solution space, matrices, LR decomposition, determinants, structure of linear spaces, normed vector spaces, inner products, method of least squares, QR decomposition, introduction to MATLAB, applications

Reading:
Gilbert Strang "Introduction to linear algebra", Wellesley-Cambridge Press: Chapters 1-6, 7.1-7.3, 8.1, 8.2, 8.6

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>406-0353-AAL</td>
<td>Analysis III</td>
<td>E-</td>
<td>4 credits</td>
<td>9R</td>
<td>M. Soner</td>
</tr>
</tbody>
</table>

Abstract
Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

Objective
Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.

Content
Laplace Transforms:
- Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
- Transforms of Derivatives and Integrals, ODEs
- Unit Step Function, t-Shifting
- Short Impulses, Dirac's Delta Function, Partial Fractions
- Convolution, Integral Equations
- Differentiation and Integration of Transforms
- Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform
- Partial Differential Equations:
- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates: Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

Autumn Semester 2016
Literature


For reference/complement of the Analysis I/II courses:

Christian Blatter: Ingenieur-Analysis (Download PDF)

Prerequisites / notice

Up-to-date information about this course can be found at:
http://www.math.ethz.ch/education/bachelor/lectures/hs2013/other/analysis3_itet

Mechanical Engineering Master - Key for Type

| O  | Compulsory  | E- | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended | Z  | Courses outside the curriculum |
| W  | Eligible for credits | Dr | Suitable for doctorate |

Key for Hours

| V  | lecture  |
| G  | lecture with exercise |
| U  | exercise  |
| S  | seminar  |
| K  | colloquium |
| P  | practical/laboratory course |
| A  | independent project |
| D  | diploma thesis |
| R  | revision course / private study |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh the advantages and disadvantages of these approaches.

This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

Aims:

- Theoretical and methodological approaches to teaching and learning that are being used in educational research or empirical learning, and their historical development.
- Thematic emphases: The learning process, learning environment, learning and teaching strategies, learning motivation (dis)advantages, learning groups, co-operation strategies.

The lecture notes will be distributed in the course of the lectures. The study of the readings is compulsory. The topics discussed in lectures are also reflected in the weekly assignments.

Prerequisites:

- Knowledge of empirical learning research.

Literature


Weitere Literatur wird in der Lehrveranstaltung genannt.

Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:

- Testentwicklung
- Gütekriterien von Tests
- Aufgabenkonstruktion
- Datenauswertung
- Rasch-Modell
- Internationale Vergleichstests
- Zulassungsstests

Weitere Angaben zu den Leistungsnachweisen werden im Rahmen der Startveranstaltung abgegeben und erläutert.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
<tr>
<td></td>
<td>This lecture is only apt for students who intend to enrol in the programs &quot;Teaching Diploma&quot; or &quot;Teaching Certificate&quot;. It is about learning in childhood and adolescence.</td>
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<tr>
<td>Abstract</td>
<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<tr>
<td>Objective</td>
<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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<tr>
<td>Content</td>
<td>Thematische Schwerpunkte: Lernen als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzwerbung unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien, Geschlechtsunterschiede beim Lernen</td>
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<tr>
<td>Lecture notes</td>
<td>Folien werden zur Verfügung gestellt.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>This lecture is only apt for students who intend to enrol in the programs &quot;Lehrdiplom&quot; or &quot;Didaktisches Zertifikat&quot;. It is about learning in childhood and adolescence.</td>
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<tbody>
<tr>
<td>851-0240-03L</td>
<td>Introduction to Test Theory and Test Construction in Educational Contexts (University of Zurich)</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>University lecturers</td>
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<td>Enrolment only possible with Teaching Diploma or DC matriculation.</td>
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<tr>
<td>Abstract</td>
<td>In this seminar, students establish scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.</td>
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<tr>
<td>Objective</td>
<td>At the end of the seminar, participants will be in a position to: - describe the scientific fundamentals of test theory and test structure. - evaluate examples of scientifically-developed tests in their application context.</td>
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<tr>
<td>Lecture notes</td>
<td>Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören auch die Handouts der verschiedenen, studentischen Vorträge.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Die Leistungsnachweisen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen: - Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA) - Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung - Referat (RE) - Schreiben einer schriftlichen Arbeit</td>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0240-15L</td>
<td>Colloquium on the Science of Learning and Instruction</td>
<td>W</td>
<td>1</td>
<td>1K</td>
<td>E. Stern, P. Greutmann, further lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH).</td>
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<tr>
<td>Objective</td>
<td>Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.</td>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0242-05L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td>Abstract</td>
<td>In this seminar, students establish scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.</td>
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<td>Objective</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen: - Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA) - Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung - Referat (RE) - Schreiben einer schriftlichen Arbeit</td>
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</table>
This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objectives:
- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on teaching and instruction

Prerequisites / notice:
Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

851-0242-07L Human Intelligence W 1 credit 1S E. Stern, P. Edelsbrunner, B. Rütsche

Abstract:
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

Objectives:
- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

851-0242-08L Research Methods in Educational Science W 1 credit 1S P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler

Abstract:
Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objectives:
- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

851-0240-22L Coping with Psychosocial Demands of Teaching (EW4 W 2 credits 3S A. Deiglmayr, P. Greutmann, U. Markwalder

Abstract:
In this class, students will learn concepts and skills for coping with psychosocial demands of teaching.

Objectives:
(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-1079-00L</td>
<td>Teaching Internship including Examination Lessons Mechanical and Process Engineering</td>
<td>W</td>
<td>6 credits</td>
<td>13P</td>
<td>S. P. Kaufmann, J. Dual</td>
</tr>
</tbody>
</table>

The teaching internship can just be visited if all other courses of TC are completed.

Repetition of the teaching internship is excluded even if the examination lessons are to be repeated.

Abstract:
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Objectives:
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practice finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils’ work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäß Anleitung und reichen sie bis am Vortag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
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<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

Voraussetzung: Erziehungswissenschaftliche Lehrveranstaltung schon absolviert oder gleichzeitig.

### Further Subject Didactics

#### Subject Didactics I for D-MAVT and D-ITET

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-1061-00L</td>
<td>Subject Didactics I for D-MAVT and D-ITET</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>S. P. Kaufmann, J. Dual</td>
</tr>
</tbody>
</table>

#### Abstract

Didactical methods in mechanical and electrical engineering.

#### Objective

- The students can plan, conduct and critically reflect single lessons.
- They orient themselves towards the academic goals and take into account existing knowledge, the professional environment and the ambitions of the students.
- They can apply the basic teaching principles meaningfully in their subject and suitably structure the learning phases.
- They can reduce and present complex technical content such that it is in a form suitable for the students to learn.
- They have considered examples of the common conceptual errors encountered by students.

#### Content

- Didactic analysis
- Competences and goals
- Preparation and wrap-up of lessons
- Process and structure of a typical lesson
- Teaching techniques (informative introduction to lessons, Advance Organizer, learning assignments, frontal teaching, questions, assignments, feedback)
- Assignments and short tests
- Media and language competence
- Conceptual change, misconceptions
- Integration of the subcomponents of a lesson.

#### Literature


#### Prerequisites / notice

Voraussetzung: Erziehungswissenschaftliche Lehrveranstaltung schon absolviert oder gleichzeitig.

### Mechanical and Process Engineering TC - Key for Type

<table>
<thead>
<tr>
<th>Letters</th>
<th>Type</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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#### Key for Hours

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<th>Letter</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<td>exercise</td>
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<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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#### ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
**Materials Science Bachelor**

**1. Semester**

**Basis Courses Part 1**

**First Year Examinations**

### Examination Block A

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-0261-GUL</td>
<td>Analysis I</td>
<td>O</td>
<td>8 credits</td>
<td>5V+4U</td>
<td>A. Steiger</td>
</tr>
</tbody>
</table>

**Abstract**

Differential and integral calculus for functions of one and several variables; vector analysis; ordinary differential equations of first and of higher order, systems of ordinary differential equations; power series. The mathematical methods are applied in a large number of examples from mechanics, physics and other areas which are basic to engineering.

**Objective**

Introduction to the mathematical foundations of engineering sciences, as far as concerning differential and integral calculus.

**Literature**

U. Stammbach: Analysis I/II

**Prerequisites / notice**

Die Übungsaufgaben (inkl. Multiple Choice) sind ein wichtiger Bestandteil der Lehrveranstaltung. Es wird erwartet, dass Sie mindestens 75% der wöchentlichen Serien bearbeiten und zur Korrektur einreichen.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0151-00L</td>
<td>Linear Algebra</td>
<td>O</td>
<td>4 credits</td>
<td>3G+2U</td>
<td>V. C. Gradinaru, R. Käppeli</td>
</tr>
</tbody>
</table>

**Abstract**

Contents: Linear systems - the Gaussian algorithm, matrices - LU decomposition, determinants, vector spaces, least squares - QR decomposition, linear maps, eigenvalue problem, normal forms - singular value decomposition; numerical aspects; introduction to MATLAB.

**Objective**

Einführung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte

**Lecture notes**

K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, S. Auflage 2002

**Literature**

K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, S. Auflage 2002

### Examination Block B

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-3001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>C. Padeste, P. J. Walde, W. R. Caseri</td>
</tr>
</tbody>
</table>

**Abstract**

General Chemistry I: Stoichiometry, atoms, molecules, chemical bond and molecular structure, gases, solutions, chemical equilibrium, solubility, acids and bases, thermodynamics, electrochemistry, kinetics.

**Objective**

Introduction to general and inorganic chemistry.

**Content**

1) Atoms, molecules, periodic table of the elements
2) Stoichiometry: Mole, chemical equations, elemental analyses
3) Reactions in water, stoichiometry in solutions
4) Thermochemistry: Energy and enthalpy, thermochemical equations, Hess theorem
5) Gases: Gas laws, reactions and stoichiometry in the gas phase, kinetic theory
6) Atomic structure and binding models: ionic, covalent and metallic bonds, Lewis- and resonance formula, electronegativity and polarity, VSEPR model
7) Liquids and solids, phase transitions
8) Solutions; dissolution processes, colligative properties
9) Kinetics: reaction rates, temperature dependence, reaction orders and reaction laws, collision theory, catalysis
11) Acid-base equilibria: acid/base-concepts, pH calculations, buffer systems, titrations
12) Dissolution and equilibria of complex formation
13) Thermodynamics: 3 laws of thermodynamics, free enthalpy and equilibrium
14) Redox reactions and electrochemistry: Faraday's laws, electrode potential and Nernst equation
15) Complexes: equilibria, structure and isomerism

**Lecture notes**

Folienskript wird jeweils vor den vorlesungsstunden als PDF versandt.

**Literature**


### Examination Block C

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>327-0103-00L</td>
<td>Introduction to Materials Science</td>
<td>O</td>
<td>3 credits</td>
<td>3G</td>
<td>M. Niederberger, N. Spencer, P. Uggowitzer</td>
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</tbody>
</table>

**Abstract**

Fundamental knowledge and understanding of the atomistic and macroscopic concepts of material science.

**Objective**

Basic concepts in materials science.

**Content**

Contents:

- Atomic structure
- Atomic bonds
- Crystalline structure, perfection - imperfection
- Diffusion
- Mechanical and thermal properties
- Phase diagrams
- Kinetics
- Structural materials
- Electric, magnetic and optical properties of materials
- Materials selection criteria

**Lecture notes**

http://www.multimat.mat.ethz.ch/education/lectures/intro.html

**Literature**

James F. Shackelford


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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>327-0104-00L</td>
<td>Crystallography</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>M. Fiebig</td>
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</tbody>
</table>

**Abstract**

Introduction into the fundamental relationships between chemical composition, crystal structure, symmetry and physical properties of solids.
Objective
Introduction into the fundamental relationships between chemical composition, crystal structure, symmetry and physical properties of solids. Emphasis: group-theoretical introduction into symmetry, discussion of the factors governing the formation of crystal structures, structural dependence of physical properties, fundamentals of experimental techniques probing the crystal structure.

Content
Symmetry and order: lattices, point groups, space groups.

Crystal chemistry: geometrical, physical and chemical factors governing the formation of crystal structures; close sphere packings; typical basic crystal structures; lattice energy; magnetic crystals; quasicrystals.

Structure/property relationships: Example quartz (piezoelectricity); perovskite and derivative structures (ferroelectrics and high-temperature superconductors); magnetic materials.

Materials characterization: diffraction techniques, optical techniques.

Lecture notes
A script of the lecture until 2014 is available. New script: to be decided.

Literature

Prerequisites / notice
Organisation: Two hours of lectures per week accompanied by one hour of exercises.

Additional Basic Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>327-0105-00L</td>
<td>Introduction to Scientific Practice for Material Scientists</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>S. Morgenthaler Kobas, M. B. Willeke</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>The students obtain a first insight into the world of materials research and are introduced to the scientific method, as it is applied in materials research and industry. The students practice acquiring, analysing and synthesising scientific information and data, and communicating their findings in written and oral form.</td>
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<td>- can protocol lab experiments correctly in a lab journal.</td>
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<td>- can analyze and present data efficiently.</td>
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<td>- can write lab reports according to standard scientific criteria.</td>
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<td>- are familiar with key rhetorical and communication rules for oral presentations.</td>
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<td>- can create effective oral presentations on scientific content.</td>
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<td>Präsentationstechnik</td>
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<td>Lecture notes</td>
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<td>Handouts werden laufend abgegeben.</td>
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<td>Prerequisites / notice</td>
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<td></td>
<td>Koordiniert mit der Lehrveranstaltung &quot;Praktikum I &amp; II&quot;.</td>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>327-0111-00L</td>
<td>Practical Laboratory Course I</td>
<td>O</td>
<td>6</td>
<td>6P</td>
<td>M. B. Willeke, M. R. Dusseiller, S. Morgenthaler Kobas, P. J. Walde</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Practical introduction into concepts and basic principles of Materials Science and Chemistry. To become acquainted with important chemical and physical methods as well as lab safety issues.</td>
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<td>Learning Objectives</td>
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<td>Content</td>
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<td>Experiments in the field of synthetic and analytical chemistry; fracture mechanics, mechanical/thermal properties (e.g. E-module), thermodynamics, colloidal chemistry, particle tracking (DLS and microscopy), corrosion, electroplating, &quot;forging, stone and wood processing&quot;, up to two computer theory experiments (using MATLAB; random numbers and traveling salesman), and further.</td>
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<td>Lecture notes</td>
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<td>The lab manual and further information for each experiment (aim of the experiment, theory, experimental procedure, data analysis) can be downloaded from the web (<a href="https://praktikum.mat.ethz.ch">https://praktikum.mat.ethz.ch</a> bzw. <a href="https://www.mat.ethz.ch/studies/bachelor/laborpraktische-ausbildung.html">https://www.mat.ethz.ch/studies/bachelor/laborpraktische-ausbildung.html</a> ).</td>
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3. Semester

Basic Courses Part 2

Examination Block 1

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0051-00L</td>
<td>Analytical Chemistry I</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>D. Günther, M.O. Ebert, R. Zenobi</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications</td>
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<td>Content</td>
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<td>Script will be for the production price</td>
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<td></td>
<td>Literature</td>
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<td></td>
<td>- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Exercices are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 &quot;Instrumental analysis of organic compounds&quot; (4th semester) is recommended.</td>
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<tr>
<td><strong>327-0309-00L</strong></td>
<td><strong>Organic Chemistry in Materials Science</strong></td>
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<tr>
<td><strong>Abstract</strong></td>
<td>This lecture allows the students to consolidate the basics of organic chemistry through selected exercises.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Consolidation of the basics of organic chemistry.</td>
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<tr>
<td><strong>Content</strong></td>
<td>This lecture consists predominantly of exercises and serves mainly to prepare the students intensively for aspects in materials science, based on the lecture Chemie II. A large number of questions will be provided, which will partially be discussed in the lecture while the other part is devoted to self-study.</td>
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<td><strong>402-0041-00L</strong></td>
<td><strong>Physics II</strong></td>
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<tr>
<td><strong>Abstract</strong></td>
<td>The course treats the fundamental aspects of modern Electronics, Quantum mechanics and Atomic physics.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Ziel dieser Vorlesung ist es, die grundlegenden Experimente zu kennen sowie die dazugehörende Theorie zu verstehen und sie in einfachen Problemstellungen zur Anwendung zu bringen.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Die Vorlesung &quot;Physik II&quot; ist eine Einführung in die Grundlage der modernen Elektrotechnik, der Quantenmechanik und Atomphysik. Inhalt:</td>
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<tr>
<td></td>
<td>- Einfache analoge und digitale Schaltungen</td>
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<tr>
<td></td>
<td>- Die Postulate der Wellenmechanik.</td>
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<td>- Eindimensionale Probleme (Teilchen im Kasten, Der Tunneleffekt, Der QM harmonische Oscillator)</td>
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<td>- Bewegung im Zentralefeld</td>
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<td></td>
<td>- Der Drehrimpulsoperator (Darstellung von Zuständen und Operatoren, Matrixdarstellung des Drehrimpulsoperators, Das Stern-Gerlach Experiment: der Spin, Die Addition von Drehrimpulsen in der Quantenmechanik)</td>
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<td>- Atomphysik (Die Spin-Bahn Kopplung, Der Hamilton-Operator der Spin-Bahn Wechselwirkung, Störungsrechnung für stationäre Zustände mit diskretem Spektrum, Anwendung der Störungstheorie; die Feinstrukturaufspaltung der atomaren Energieniveaus, Ein Atom im äusseren Magnetfeld: Zeeman-Effekt, Die Hyperfeinstruktur der s-Zustände)</td>
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<td>- Mehr-Teilchen Systeme (Das Energiespektrum des He-Atoms, Angeregte Zustände des Heliumatoms, Das Mendeleewschwe Periodensystem, Spektresterme)</td>
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<td>- Übergang in Folge einer zeitabhängigen, periodischen Störung (Magnetische Resonanz (I. Rabi, Phys. Rev. 51, 652 (1937), Nobel Preis 1944), Verallgemeinerung der Rabi Formel auf Übergänge in Folge einer zeitabhängigen, periodischen Störung)</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Ein Skript wird verteilt.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
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<tr>
<td><strong>551-0015-00L</strong></td>
<td><strong>Biology I</strong></td>
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<tr>
<td><strong>Abstract</strong></td>
<td>The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Die folgenden Kapitelnummern beziehen sich auf das der Vorlesung zugrundeliegende Lehrbuch &quot;Biology&quot; (Campbell &amp; Rees, 10th edition, 2015)</td>
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<tr>
<td></td>
<td>Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt</td>
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<td></td>
<td>1. Aufbau der Zelle</td>
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<td></td>
<td>Kapitel 5: Struktur und Funktion biologischer Makromoleküle</td>
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<td></td>
<td>Kapitel 6: Eine Tour durch die Zelle</td>
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<td></td>
<td>Kapitel 7: Membranstruktur und-funktion</td>
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<td></td>
<td>Kapitel 8: Einführung in den Stoffwechsel</td>
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<td></td>
<td>Kapitel 9: Zelluläre Atmung und Speicherung chemischer Energie</td>
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<td></td>
<td>Kapitel 10: Photosynthese</td>
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<td>Kapitel 12: Der Zellzyklus</td>
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<td>Kapitel 17: Vom Gen zum Protein</td>
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<td>2. Allgemeine Genetik</td>
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<td>Kapitel 13: Meiose und Reproduktionszyklen</td>
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<td>Kapitel 14: Mendel'sche Genetik</td>
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<td>Kapitel 15: Die chromosomale Basis der Vererbung</td>
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<td></td>
<td>Kapitel 16: Die molekulare Grundlage der Vererbung</td>
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<td></td>
<td>Kapitel 18: Genetik von Bakterien und Viren</td>
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<td></td>
<td>Kapitel 46: Tierische Reproduktion</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Der Vorlesungstoff ist sehr nahe am Lehrbuch gehalten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Das folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
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#### Examination Block 2

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0603-00L</td>
<td><strong>Stochastics (Probability and Statistics)</strong></td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>M. H. Maathuis</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for normally distributed data, point estimation, and two-sample tests.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Knowledge of the basic principles of probability and statistics.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Introduction to probability theory, some basic principles from mathematical statistics and basic methods for applied statistics.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Lecture notes</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Lecture notes</td>
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</table>
Analysis III

Abstract
Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

Objective
Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.

The first lecture is on Thursday, September 29 13-15 in HG F 7 and video transmitted into HG F 5.

The exercises Sheet are here: http://www.vvz.ethz.ch/Vorlesungsverzeichnis/lerneinheitPre.do?semkez=2016W&lang=de&ansicht=LEARNMATERIALIEN&lerneinheitId=108855

The coordinator is Claudio Sibilia (see https://www.math.ethz.ch/the-department/people.html?u=sibiliac)

The first exercise session is on Thursday, September 22 or resp. Friday, September 23. If you would like feedback on your work, please give it to your course assistant or leave it in the box of your course assistant in HG F 27. The due Date is one week later the assignment.

Office hour (Praesenz): Thursday 16-17, NO E 39.

Content
Laplace Transforms:
- Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
- Transforms of Derivatives and Integrals, ODEs
- Unit Step Function, t-Shifting
- Short Impulses, Dirac's Delta Function, Partial Fractions
- Convolution, Integral Equations
- Differentiation and Integration of Transforms

Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:
- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates: Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

Download the syllabus: https://polybox.ethz.ch/index.php/s/bu5KY8vWNMOaAa

Errata: https://polybox.ethz.ch/index.php/s/RcsFm70tWChEqSjH

Alessandra Iozzi’s Lecture notes:  https://polybox.ethz.ch/index.php/s/RcsFm70tWChEqSjH

Literature

For reference/complement of the Analysis I/II courses:
Christian Blatter: Ingenieur-Analyse (Download PDF)

Programming Techniques in Materials Science

Abstract
This course introduces the general computing and programming skills which are necessary to perform numerical computations and simulations in materials science. This is achieved using the numerical computing environment Matlab and through the use of many practical examples and exercises.

Objective
On passing this course, the students should be able to develop their own programs for performing numerical computations and simulations, and they should be able to analyse and amend existing code.

Content
Introduction to Matlab; input/output; structured programming using loops and conditional execution; modular Programming using functions; flow diagrams; numerical accuracy; example: random walk model.

Materials Science I

Abstract
Basic concepts of metal physics, ceramics, polymers and their technology.

Objective
Based on the lecture "Introduction to Materials Science" this lecture aims to give a detailed understanding of important aspects of materials science, with special emphasis on metallic and ceramic materials.

Content
Thermodynamics and phase diagrams, crystal interfaces and microstructure, diffusional transformations in solids, and diffusionless transformations will be presented for metallic alloys. The basics of the ionic and covalent chemical bonds, the bond energy, the crystalline structure, four important structural ceramics, and the properties of glasses and glass ceramics will be presented for ceramic materials.
Materials Characterisation Methods

The lecture course is aimed to qualifying the student to choose the optimum characterization method according to the questions posed.

The main topics are: Thermal Analysis (TD, TG, TM, DTA, DSC), light microscopy, diffraction methods (XRD, NRD, SAD), electron microscopy (TEM, HRTEM, STEM, HAADF-STEM, SEM, ESEM, EFEM, EDX, EELS). The emphasis is on the discussion of the fundamentals of these characterization methods.

Script is provided.


Barsoum MW: Fundamentals of Ceramics:


- "Brevieral Ceramics" published by the "Verband der Keramischen Industrie e.V.", ISBN 3-924158-77-0, partly its contents may be found in the internet @ http://www.keramverband.de/brevier_engl/brevier.htm or on our homepage

- Silicon-Based Structural Ceramics (Ceramic Transactions), Stephen C. Danforth (Editor), Brian W. Sheldon, American Ceramic Society, 2003,


- Phase relationships in the zirconia-yttria system, HGM Scott - Journal of Materials Science, 1975, Springer

- Thommy Ekström and Mats Nygren, SiAION Ceramics J Am Cer Soc Volume 75 Page 259 - February 1992


- In the first part of the lecture the bases are obtained for metals. In the second part the basics of ceramics will be presented.

- One part of the lecture will be taught in English, but most of it in German.

5. Semester

Basic Courses Part 2

Examination Block 5

Number
Title
Type
ECTS
Hours
Lecturers
327-0504-00L
Materials Characterisation Methods
O
3 credits
2V+1U
L. Heyderman
Abstract
The lecture course is aimed to qualifying the student to choose the optimum characterization method according to the questions posed.

The main topics are: Thermal Analysis (TD, TG, TM, DTA, DSC), light microscopy, diffraction methods (XRD, NRD, SAD), electron microscopy (TEM, HRTEM, STEM, HAADF-STEM, SEM, ESEM, EFEM, EDX, EELS).

Objective
The lecture course is aimed to qualifying the student to choose the optimum characterization method according to the questions posed.

Content
Introduction into the fundamentals of materials characterization; Thermal Analysis (TD, TG, TM, DTA, DSC), light microscopy, diffusion methods (XRD, NRD, SAD), electron microscopy (TEM, HRTEM, STEM, HAADF-STEM, SEM, ESEM, EFEM, EDX, EELS). The emphasis is on the discussion of the fundamentals of these characterization methods.

Lecture notes
Script is provided.

Literature

327-0508-00L
Simulation Techniques in Materials Science
O
4 credits
2V+2U
C. Ederer
Abstract
Introduction to simulation techniques that are relevant for material science. Simulation methods for continua (finite differences, finite elements), mesoscopic methods (cellular automata, mesoscopic Monte Carlo methods), microscopic methods (Molecular Dynamics, Monte-Carlo simulations, Density Functional Theory).

Data: 06.11.2018 12:57
Autumn Semester 2016
Page 1086 of 1571
Objective

Learn techniques which are used in the computer-based study of the physics of materials; Obtain an overview of which simulation techniques are useful for which type of problems; develop the capability to transform problems in materials science into a form suitable for computer studies, including writing the computer program and analyzing the results.

Content

- Modeling and simulation techniques in materials science.
- Simulation methods for continua (finite differences, basic idea of finite elements).
- Mesoscopic methods (Cellular automata, phase-field models, mesoscopic Monte Carlo methods).
- Microscopic methods (Molecular dynamics, Monte-Carlo simulation for many-particle systems, basic idea of density functional theory).

Literature


327-0407-00L Materials Physics I

Objectives

- Repetition and advancement of dislocation theory.
- Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.
- Case studies in alloying to illustrate the mechanisms.

Content

PART I: Structure of solid matter, real and reciprocal space

- Understanding the electronic properties of solids is at the heart of modern society and technology. The aim of this course is to provide fundamental concepts that allow the student to relate the microscopic structure of matter and the quantum mechanical behavior of electrons to the macroscopic properties of materials. Beyond fundamental curiosity, such level of understanding is required in order to develop and appropriately describe new classes of materials for future technology applications. By the end of the course the student should have developed a semi-quantitative understanding of basic concepts in solid state physics and be able to appreciate the pertinence of different models to the description of specific material properties.

PART II: Dynamics of atoms in crystals

- Lattice vibrations and phonons in 1D, phonons in 1D chains with monoatomic basis, phonon in 1D chains with a diatomic basis, optical and acoustic modes, phase and group velocities, phonon dispersion and eigenvectors. Phonons in 2D and 3D.

PART III: Electron states and energy bands in molecules and solids


PART IV: Electrical and heat conduction

- Dynamics of electrons in energy bands, phase and group velocity, crystal momentum, the effective mass concept, scattering phenomena. The equilibrium and non-equilibrium distribution function for electrons. The Boltzmann equation in the presence of external fields in the relaxation time approximation.

PART V: Semiconductors: concepts and devices


Lecture notes


Prerequisites / notice

- Physics I and II. Knowledge of basic quantum mechanical concepts. The lecture will be given in English. The script will be available in English.

>>> Examination Block 6

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>327-0501-00L</td>
<td>Metals I</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>R. Spolenak</td>
</tr>
</tbody>
</table>

Abstract

Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

Objective

Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.
Content

Dislocation theory:
- Properties of dislocations, motion and kinetics of dislocations, dislocation-dislocation and dislocation-boundary interactions, consequences of partial dislocations, sessile dislocations
- Hardening theory:
  a. solid solution hardening: case studies in copper-nickel and iron-carbon alloys
  b. particle hardening: case studies on aluminium-copper alloys
- High temperature plasticity:
  - thermally activated glide
  - power-law creep
  - diffusional creep: Coble, Nabarro-Herring
- deformation mechanism maps
- Case studies in turbine blades
- superplasticity
- alloying effects

Hardening theory:

- Solid solution hardening: case studies in copper-nickel and iron-carbon alloys
- Particle hardening: case studies in aluminium-copper alloys

High temperature plasticity:

- Thermally activated glide
- Power-law creep
- Diffusional creep: Coble, Nabarro-Herring
- Deformation mechanism maps
- Case studies in turbine blades
- Superplasticity
- Alloying effects

Literature

- Gottstein, Physikalische Grundlagen der Materialkunde, Springer Verlag
- Haasen, Physikalische Metallkunde, Springer Verlag
- Rössler/Harders/Bäker, Mechanisches Verhalten der Werkstoffe, Teubner Verlag
- Porter/Easterling, Transformations in Metals and Alloys, Chapman & Hall
- Hull/Bacon, Introduction to Dislocations, Butterworth & Heinemann
- Courtney, Mechanical Behaviour of Materials, McGraw-Hill

327-0502-00L Polymers I  O  3 credits  2V+1U  M. Kröger

Abstract

Physical foundations of single polymer molecules and interacting chains.

Objective

The course offers a modern approach to the understanding of universal static and dynamic properties of polymers.

Content

Polymer Physics:
1. Introduction to Polymer Physics, Random Walks
2. Excluded Volume
3. Structure Factor from Scattering Experiments
4. Persistence
5. Solvent and Temperature Effects
6. Flory theory
7. Self-consistent field theory
8. Interacting Chains, Phase Separation and Critical Phenomena
9. Rheology
10. Numerical methods in polymer physics, computer experiments

Lecture notes

A script is available at http://www.polyphys.mat.ethz.ch/education/courses/polymere-I

Literature


Prerequisites / notice

Computer experiments will use the simple MATLAB programming language and will be made available, if necessary or useful.

327-0503-00L Ceramics I  O  3 credits  2V+1U  M. Niederberger, T. Graule, A. R. Studart

Abstract

Introduction to ceramic processing.

Objective

The aim is the understanding of the basic principles of ceramic processing.

Content

- Basic chemical processes for powder production.
- Liquid-phase synthesis methods.
- Sol-Gel processes.
- Classical crystallization theory.
- Gas phase reactions.
- Basics of the colloidal chemistry for suspension preparation and control.
- Characterization techniques for powders and colloids.
- Shaping techniques for bulk components and thin films.
- Sintering processes and microstructural control.

Lecture notes

See: http://www.multimat.mat.ethz.ch/education/lectures/ceramics.html

Literature

Books and references will be given on the lecture notes.

327-1221-00L Biological and Bio-Inspired Materials  O  3 credits  3G  A. R. Studart, I. Burgert, E. Cabane, R. Nicolosi Libanori

Abstract

Students that already enrolled in this course during their Bachelor's degree studies are not allowed to enrol again in their Master's.

Objective

The aim of this course is to impart knowledge on the underlying principles governing the design of biological materials and on strategies to fabricate synthetic model systems whose structural organization resembles those of natural materials.

Content

This course is structured in 3 blocks:
- Biological engineering principles
- Basic building blocks found in biological materials
- Biological engineering principles
- Basic building blocks found in biological materials

Block (II): Replicating biological design principles in synthetic materials
- Biological and bio-inspired materials: polymer-reinforced and ceramic-toughened composites
- Lightweight biological and bio-inspired materials
- Functional biological and bio-inspired materials: surfaces, self-healing and adaptive materials

Block (III): Bio-inspired design and systems
- Bio-inspiration in the building environment
- Future developments in bio-inspired materials

Lecture notes

Copies of the slides will be made available for download before each lecture.
The course is mainly based on the books listed below. Additional references will be provided during the lectures.


### Basic Courses Part 3

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0511-00L</td>
<td>Practical Course V</td>
<td>O</td>
<td>6 credits</td>
<td>8P</td>
<td>M. B. Willeke, J. F. Löffler</td>
</tr>
</tbody>
</table>

**Abstract**

Acquisition of independent scientific-technical skills; project management; organization and undertaking of experiments; interpretation, scientifically and technically correct project presentation in oral and written form.

**Objective**

Acquisition of independent scientific/technical skills; project management; organization and conducting of experiments; interpretation and scientifically/technically correct presentation of projects in oral and written form.

**Content**

Supervision by DMATL research groups

Groups of students (2 or 3 per group) each work on a research project throughout the semester.

**Prerequisites / notice**

Prerequisite: Successful participation in the "Praktika I - IV" (courses within the material science bachelor study at ETH) or comparable practical lab courses.

### Compensatory Courses

*Only possible after consultation with the Director of Studies.*

### Basic Courses Part 2 - Examination Block 5 (ONLY for Progr. Reg. 2012)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0407-00L</td>
<td>Materials Physics I</td>
<td>O</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>P. Gambardella</td>
</tr>
</tbody>
</table>

**Abstract**

This course introduces classical and quantum mechanical concepts for the understanding of material properties from a microscopic point of view. The lectures focus on the static and dynamic properties of crystals, the formation of chemical bonds and electronic bands in molecules, insulators, metals, and semiconductors, and on the thermal and electrical properties that emerge from this analysis.

**Objective**

Providing physical concepts for the understanding of material properties:

Understanding the electronic properties of solids is at the heart of modern society and technology. The aim of this course is to provide fundamental concepts that allow the student to relate the microscopic structure of matter and the quantum mechanical behavior of electrons to the macroscopic properties of materials. Beyond fundamental curiosity, such level of understanding is required in order to develop and appropriately describe new classes of materials for future technology applications. By the end of the course the student should have developed a semi-quantitative understanding of basic concepts in solid state physics and be able to appreciate the pertinence of different models to the description of specific material properties.
PART I: Structure of solid matter, real and reciprocal space

The crystal lattice, Bravais lattices, primitive cells and unit cells, Wigner-Seitz cell, primitive lattice vectors, lattice with a basis, examples of 3D and 2D lattices.

Fourier transforms and reciprocal space, reciprocal lattice vectors, Brillouin zones


PART II: Dynamics of atoms in crystals

Lattice vibrations and phonons in 1D, phonons in 1D chains with monatomic basis, phonon in 1D chains with a diatomic basis, optical and acoustic modes, phase and group velocities, phonon dispersion and eigenvectors. Phonons in 2D and 3D.

Quantum mechanical description of lattice waves in solids, the harmonic oscillator, the concept of phonon, phonon statistics, Bose-Einstein distribution, phonon density of states, Debye and Einstein models, thermal energy, heat capacity of solids.

PART III: Electron states and energy bands in molecules and solids

Electronic properties of materials, classical concepts: electrical conductivity, Hall effect, thermoelectric effects. Drude model. Transition to quantum models and review of quantum mechanical concepts.

Introduction to molecular orbital theory and linear combination of atomic orbitals (LCAO). The H2+ molecule, homonuclear and heteronuclear molecules, benzene, sigma and pi bonds, sp3 and sp2 hybridization. From molecules to periodic crystal structures.

The free electron gas: Fermi statistics, Fermi energy and Fermi surface, density of states in k-space and as a function of energy. Inadequacy of the free electron model.


PART IV: Electrical and heat conduction

Dynamics of electrons in energy bands, phase and group velocity, crystal momentum, the effective mass concept, scattering phenomena. The equilibrium and non-equilibrium distribution function for electrons. The Boltzmann equation in the presence of external fields in the relaxation time approximation.

Electrical and thermal conductivities revisited. Electron transport due to electric fields (drift) and concentration gradients (diffusion). Einstein's relations. Transport of heat by electrons, Seebeck effect and thermopower, Peltier effect, thermoelectric cooling, thermoelectric energy conversion.

PART V: Semiconductors: concepts and devices


Industrial Internship or Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0001-00L</td>
<td>Industrial Internship ◼ Only for Materials Science BSc.</td>
<td>W</td>
<td>10</td>
<td></td>
<td>external organisers</td>
</tr>
<tr>
<td>Abstract</td>
<td>12 weeks of industrial internship which is completed with a written report.</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>The main objective of the 12-week internship is to expose bachelor's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.</td>
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</table>

| 327-0002-00L | Project ◼ Carrying out outside of D-MATL: Only possible after consultation with the Director of Studies. | W    | 10   | 21P   | Lecturers     |
| Abstract    | Project in a research group at ETH or at an University of 12 weeks. The project is completed with a written report. |      |      |       |               |
| Objective   | The main objective of the 12-week research project is to expose bachelor's students to the professional research environment. During this period, students have the opportunity to be involved in on-going projects at the host institution. |      |      |       |               |

GESS Science in Perspective

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/ÜZH

Recommended GESS Science in Perspective (Type B) for D-MATL.

Materials Science Bachelor - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
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</table>
### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
# Materials Science Master

## Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0505-00L</td>
<td>Surfaces, Interfaces and their Applications I</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>N. Spencer, M. P. Heuberger, L. Isa</td>
</tr>
</tbody>
</table>

**Abstract**

After being introduced to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most important techniques that can be used to characterize surfaces. Later, liquid interfaces are treated, followed by an introduction to the fields of tribology (friction, lubrication, and wear) and corrosion.

**Objective**

To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.

**Content**

- Physical Structure of Surfaces
- Surface Forces (static and dynamic)
- Adsorbates on Surfaces
- Surface Thermodynamics and Kinetics
- The Solid-Liquid Interface
- Electron Spectroscopy
- Vibration Spectroscopy on Surfaces
- Scanning Probe Microscopy

Introduction to Tribology
Introduction to Corrosion Science

**Lecture notes**

Script Download: https://eskript.ethz.ch/catalog/matl

**Literature**


**Prerequisites / notice**

Chemistry:
- General undergraduate chemistry
- including basic chemical kinetics and thermodynamics

Physics:
- General undergraduate physics
- including basic theory of diffraction and basic knowledge of crystal structures

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>327-1201-00L</td>
<td>Transport Phenomena I</td>
<td>W Dr</td>
<td>4</td>
<td>4G</td>
<td>H. C. Öttinger</td>
</tr>
</tbody>
</table>

**Abstract**

Phenomenological approach to "Transport Phenomena" based on balance equations supplemented by thermodynamic considerations to formulate the underdetermined fluxes in the local species mass, momentum, and energy balance equations; fundamentals, applications, and simulations

**Objective**

The teaching goals of this course are on five different levels:
- Deep understanding of fundamentals: local balance equations, constitutive equations for fluxes, entropy balance, interfaces, idea of dimensionless numbers, ...
- Ability to use the fundamental concepts in applications
- Insight into the role of boundary conditions
- Knowledge of a number of applications
- Flavor of numerical techniques: finite elements, finite differences, lattice Boltzmann, Brownian dynamics, ...

**Content**

Approach to Transport Phenomena
- Diffusion Equation
- Brownian Dynamics
- Refreshing Topics in Equilibrium Thermodynamics
- Balance Equations
- Forces and Fluxes
- Measuring Transport Coefficients
- Pressure-Driven Flows
- Driven Separations
- Complex Fluids

**Lecture notes**

A detailed manuscript is provided; this manuscript will be developed into a book entitled "A Modern Course in Transport Phenomena" by David C. Venerus and Hans Christian Öttinger

**Literature**

- Book: "Transport Phenomena" (2nd Ed. (Wiley, 2001)
- Book: "Non-Equilibrium Thermodynamics" (2nd Ed. (Dover, 1984)
- Book: "Analysis of Transport Phenomena" (Oxford University Press, 1996)

**Prerequisites / notice**

Complex numbers, Vector analysis (integrability; Gauss' divergence theorem), Laplace and Fourier transforms. Ordinary differential equations (basic ideas). Linear algebra (matrices; functions of matrices; eigenvectors and eigenvalues; eigendecompositions). Probability theory (Gaussian distributions; Poisson distributions; averages; moments; variances; random variables). Numerical mathematics (integration). Equilibrium thermodynamics (Gibbs' fundamental equation; thermodynamic potentials; Legendre transforms). Maxwell equations. Programming and simulation techniques (Matlab, Monte Carlo simulations).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-1202-00L</td>
<td>Solid State Physics and Chemistry of Materials I</td>
<td>W Dr</td>
<td>4</td>
<td>4G</td>
<td>N. Spaldin</td>
</tr>
</tbody>
</table>

**Abstract**

In this course we study how the properties of solids are determined from the chemistry and arrangement of the constituent atoms, with a focus on materials that are not well described by conventional band theories because their behavior is governed by strong quantum-mechanical interactions.

**Objective**

Electronic properties and band theory description of conventional solids
- Electron-lattice coupling and its consequences in functional materials
- Electron-spin/orbit coupling and its consequences in functional materials
- Structure/property relationships in strongly-correlated materials

**Content**

In this course we study how the properties of solids are determined from the chemistry and arrangement of the constituent atoms, with a focus on materials that are not well described by conventional band theories because their behavior is governed by strong quantum-mechanical interactions. We begin with a review of the successes of band theory in describing many properties of metals, semiconductors and insulators, and we practise building up band structures from atoms and describing the resulting properties. Then we explore classes of systems in which the coupling between the electrons and the lattice is so strong that it drives structural distortions such as Peierls instabilities, John-Teller distortions, and ferroelectric transitions. Next, we move on to strong couplings between electronic charge and spin- and/or orbital- angular momentum, yielding materials with novel magnetic properties. We end with examples of the complete breakdown of single-particle band theory in so-called strongly correlated materials, which comprise for example heavy-fermion materials, frustrated magnets, materials with unusual metal-insulator transitions and the high-temperature superconductors.

**Lecture notes**

An electronic script for the course is provided at https://eskript.ethz.ch/catalog/matl
Handouts with additional reading will be made available during the course and posted on the page accessible through MyStudies.

Grundlagen für Materialphysik, 327-0406-00L
Materiaphysik I, 327-0407-00L
Materiaphysik II, 327-0506-00L

or equivalent classes from another institution.

<table>
<thead>
<tr>
<th>327-1203-00L</th>
<th>Complex Materials I: Synthesis &amp; Assembly</th>
<th>W Dr</th>
<th>4 credits</th>
<th>4G</th>
<th>M. Niederberger, D. Koziej</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Introduction to materials synthesis concepts based on the assembly of differently shaped objects of varying chemical nature and length scales.</td>
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</tr>
<tr>
<td>Objective</td>
<td>The aim is a) to learn how to design and create objects as building blocks with a particular shape and a defined recognition pattern, b) to understand the chemistry that allows for the creation of such hard and soft objects within a certain size range, and c) to master the concepts to assemble these objects into hierarchically structured materials.</td>
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<tr>
<td>Content</td>
<td>The course is divided into two parts: I) synthesis of 0-, 1-, 2-, and 3-dimensional building blocks with a length scale from nm to µm, and II) assembly of these building blocks into 1-, 2- and 3-dimensional structures over several length scales up to cm. In part I, various methodologies for the synthesis of the building blocks will be discussed, including Turkevich and Brust-Schiffrin-method for gold nanoparticles, hot-injection for semiconducting quantum dots, aqueous and nonaqueous sol-gel chemistry for metal oxides, or gas- and liquid-phase routes to carbon nanostructures. Part II is focused on self- and directed assembly methods that can be used to create higher order architectures from those building blocks connecting the microscopic with the macroscopic world. Examples include photonic crystals, nanocrystal solids, colloidal molecules, mesocrystals or particle-based foams and aerogels.</td>
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</table>

| Lecture notes | References to original articles and reviews for further reading will be provided on the lecture notes. |
| Literature    | http://www.multimat.mat.ethz.ch/education/lectures/complex_lecture.html |

<table>
<thead>
<tr>
<th>327-1204-00L</th>
<th>Materials at Work</th>
<th>W Dr</th>
<th>4 credits</th>
<th>4S</th>
<th>R. Spolenak, E. Dufresne, R. Koopmans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course attempts to prepare the student for a job as a materials engineer in industry. The gap between fundamental materials science and the materials engineering of products should be bridged. The focus lies on the practical application of fundamental knowledge allowing the students to experience application related materials concepts with a strong emphasis on case-study mediated learning.</td>
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<tr>
<td>Objective</td>
<td>Teaching goals:</td>
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<tr>
<td></td>
<td>to learn how materials are selected for a specific application</td>
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<tr>
<td></td>
<td>to understand how materials around us are produced and manufactured</td>
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<td></td>
<td>to understand the value chain from raw material to application</td>
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<td></td>
<td>to be exposed to state of the art technologies for processing, joining and shaping</td>
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<td>to be exposed to industry related materials issues and the corresponding language (terminology) and skills</td>
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<td></td>
<td>to create an impression of how a job in industry &quot;works&quot;, to improve the perception of the demands of a job in industry</td>
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<tr>
<td>Content</td>
<td>This course is designed as a two semester class and the topics reflect the contents covered in both semesters.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Lectures and case studies encompass the following topics:</td>
<td></td>
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<tr>
<td></td>
<td>Strategic Materials (where do raw materials come from, who owns them, who owns the IP and can they be substituted)</td>
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<td></td>
<td>Materials Selection (what is the optimal material (class) for a specific application)</td>
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<td></td>
<td>Materials systems (subdivisions include all classical materials classes)</td>
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<td></td>
<td>Processing</td>
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<td></td>
<td>Joining (assembly)</td>
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<td></td>
<td>Shaping</td>
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<td></td>
<td>Materials and process scaling (from nm to m and vice versa, from mg to tons)</td>
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<td></td>
<td>Sustainable materials manufacturing (cradle to cradle) Recycling (Energy recovery)</td>
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<tr>
<td></td>
<td>After a general part of materials selection, critical materials and materials and design four parts consisting of polymers, metals, ceramics and coatings will be addressed.</td>
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<tr>
<td></td>
<td>In the fall semester the focus is on the general part, polymers and alloy case studies in metals. The course is accompanied by hands-on analysis projects on everyday materials.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Manufacturing, Engineering &amp; Technology</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Serope Kalpakjian, Steven Schmid</td>
<td></td>
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<table>
<thead>
<tr>
<th>327-1207-00L</th>
<th>Soft Materials II</th>
<th>W Dr</th>
<th>4 credits</th>
<th>4G</th>
<th>J. Vermant, L. Isa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>In the second part of the course we will introduce the experimental tools to study the materials at the invariably wide range of length scales, which are embedded in the microstructures that generate the desired properties.</td>
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<tr>
<td>Objective</td>
<td>Students should be able to learn which experimental tools may help to troubleshoot a problem. A key aspect is that students should learn to see which are the &quot;knobs that can be turned&quot;, by playing with the chemistry of the building blocks, the formulation, the physical chemistry or not the process technology.</td>
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</tbody>
</table>

Elective Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>327-2103-00L</td>
<td>Advanced Composite and Adaptive Material Systems</td>
<td>W</td>
<td>4</td>
<td>2V+2U</td>
<td>G. P. Terrasi, F. J. Clemens</td>
</tr>
</tbody>
</table>
Abstract

Enables materials scientists to work in a wide range of advanced composite and adaptive material systems. Emphasis is placed on developing advanced knowledge and understanding of their design, manufacturing, structure and properties, characterisation and applications.

Objective

Enables materials scientists to work in a wide range of advanced composite and adaptive material systems. Emphasis is placed on developing advanced knowledge and understanding of their design, manufacturing, structure and properties, characterisation and applications.

Content

The course will comprise a balance of lectures, tutorials, student presentations and laboratory classes. In addition, case study site visits will be made for certain topics to illustrate the industrial application of particular technologies.

More and more, the interest in functional fibre composites is increasing. In beginning, the main focus will be on the production of functional fibres, e.g., for fibre-based sensor and actuator composites with polymers, metals and ceramics. Optical, piezoelectric, shape memory and other fibres for advanced composite applications will be treated in detail. There will be a discussion on fibre classification, fibre production (ceramic and others), adaptive and smart materials, types of sensors and actuators (e.g., made from electro-active poly-mers), and sensor networks with piezoelectric or magnetoelectric properties (e.g., Active or Macro Fibre Composites) for adaptive material systems or structural health monitoring (SHM) of advanced composite structures.

Emphasis will be put on the underlying science of a particular process or effect rather than a detailed description of the technique or equipment.

Manufacturing of actuators driven by electro-active polymers (EAP) and sensors applications of Active Fibre Composites (AFC) will be studied in laboratory classes.

Case studies and examples drawn from structural and functional applications of advanced composite and adaptive material systems will be demonstrated.

Prerequisites / notice

ETH-course 327-0610 Composite Materials or similar course

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-4101-00L</td>
<td>Durability of Engineering Materials</td>
<td>2</td>
<td>W</td>
</tr>
<tr>
<td>327-1221-00L</td>
<td>Biological and Bio-Inspired Materials</td>
<td>3</td>
<td>W</td>
</tr>
</tbody>
</table>

Lecture notes

Copy of the overheads

Literature


Adaptronics and smart structures : basics, materials, design, and applications by H. Janocha. Publisher Springer 1999; Berlin, New York.


New York.

Adaptation and smart structures : basics, materials, design, and applications by H. Janocha. Publisher Springer 1999; Berlin, New York.


Case studies and examples drawn from structural and functional applications of advanced composite and adaptive material systems will be studied in laboratory classes.

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Prerequisite:

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</tr>
</thead>
<tbody>
<tr>
<td>327-4101-00L</td>
<td>Durability of Engineering Materials</td>
</tr>
<tr>
<td>327-1221-00L</td>
<td>Biological and Bio-Inspired Materials</td>
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Lecture notes

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Case studies and examples drawn from structural and functional applications of advanced composite and adaptive material systems will be studied in laboratory classes.

Emphasis will be put on the underlying science of a particular process or effect rather than a detailed description of the technique or equipment.

Manufacturing of actuators driven by electro-active polymers (EAP) and sensors applications of Active Fibre Composites (AFC) will be studied in laboratory classes.

Case studies and examples drawn from structural and functional applications of advanced composite and adaptive material systems will be demonstrated.
This course is structured in 3 blocks:

- **Block (I): Fundamentals of engineering in biological materials**
  - Biological engineering principles
  - Basic building blocks found in biological materials

- **Block (II): Replicating biological design principles in synthetic materials**
  - Biological and bio-inspired materials: polymer-reinforced and ceramic-toughened composites
  - Lightweight biological and bio-inspired materials
  - Functional biological and bio-inspired materials: surfaces, self-healing and adaptive materials

- **Block (III): Bio-inspired design and systems**
  - Bio-inspiration in the building environment
  - Future developments in bio-inspired materials

The course is mainly based on the books listed below. Additional references will be provided during the lectures.

### 327-0702-00L EM-Practical Course in Materials Science

<table>
<thead>
<tr>
<th>Content</th>
<th>Objective</th>
<th>Abstract</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, structural geology and structural chemistry will be reported.</td>
<td>A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.</td>
<td>Practical work on a TEM and on SEM, treatment of typical problems, data analysis, writing of a report</td>
<td>see lecture Electron Microscopy (327-0703-00L)</td>
</tr>
</tbody>
</table>

**Prerequisites / notice**

- Prerequisite: the lecture Electron Microscopy (327-0703-00L) has to be attended with success, maximum number of participants 15, work in groups of 3 people.

### 327-0703-00L Electron Microscopy in Material Science

<table>
<thead>
<tr>
<th>Content</th>
<th>Objective</th>
<th>Abstract</th>
<th>Literature</th>
</tr>
</thead>
</table>

**Lecture notes**

- Copies of the slides will be made available for download before each lecture.

### 327-2105-00L Supramolecular Aspects of Polymers

<table>
<thead>
<tr>
<th>Content</th>
<th>Objective</th>
<th>Abstract</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation, characterization and applications of polymolecular aggregates formed from amphiphilic block copolymers.</td>
<td>To become acquainted with the principles of the self-assembly of amphiphilic block copolymers into micelles and vesicles and to become acquainted with some of the properties and applications of these aggregates.</td>
<td>Preparation, characterization and applications of polymolecular aggregates formed from amphiphilic block copolymers.</td>
<td>Frank: Electron Tomography, Plenum Press, 1992. Enri: Aberration-corrected imaging in transmission electron microscopy, Imperial College Press (2010, and 2nd ed. 2015)</td>
</tr>
</tbody>
</table>

**Lecture notes**

- No script

### 151-0605-00L Nanosystems

<table>
<thead>
<tr>
<th>Content</th>
<th>Objective</th>
<th>Abstract</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures. Special emphasis on the emerging field of molecular electronic devices.</td>
<td>Familiarize students with basic science and engineering principles governing the nano domain.</td>
<td>From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures. Special emphasis on the emerging field of molecular electronic devices.</td>
<td></td>
</tr>
</tbody>
</table>
The course gives an introduction to the use of synchrotron radiation in materials science. It treats the generation of intense x-ray beams at synchrotron radiation sources and their use for the characterisation of materials properties at different length scales. As part of the course, experiments will be carried out at the Swiss Light Source, Paul Scherrer Institut.

A comprehensive understanding of the interaction of x-rays with condensed matter and their use in materials analysis; acquiring hands-on experience with the use of synchrotron radiation.

Interaction of x-rays with matter:
- Elastic scattering from bound electron, atom and assemblies of atoms; Compton scattering; principles of diffraction from crystals and scattering from disordered systems; thermal diffuse scattering, small-angle scattering from nanometre-sized objects; X-ray absorption spectroscopy; microscopy; comparison with neutron scattering, where appropriate.

The generation of high-brilliance x-ray beams at synchrotron radiation sources:
- Undulators, wigglers and bending magnets; comparison with conventional lab sources; the future x-ray free electron laser.

Determination of materials properties:
- Crystal structure; defects and strain fields; structure of surfaces and interfaces; chemical bonding properties.

New methods:
- Coherent x-ray scattering and diffractive imaging.

Instrumentation:
- Monochromator; diffractometer; detector.

Prerequisites / notice
- Course format:
  - Lectures and Mini-Review presentations: Thursday 10-13, ML F 36
  - Homework: Mini-Reviews
  - Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

402-0313-00L Materials Research Using Synchrotron Radiation
- W 6 credits 2V+2P
- L. Heyderman, V. Scagnoli

Abstract
- The course gives an introduction to the use of x-ray beams at synchrotron radiation sources and their use for the characterisation of materials properties at different length scales. As part of the course, experiments will be carried out at the Swiss Light Source, Paul Scherrer Institut.

Objective
- A comprehensive understanding of the interaction of x-rays with condensed matter and their use in materials analysis; acquiring hands-on experience with the use of synchrotron radiation.

Content
- Interaction of x-rays with matter:
  - Elastic scattering from bound electron, atom and assemblies of atoms; Compton scattering; principles of diffraction from crystals and scattering from disordered systems; thermal diffuse scattering, small-angle scattering from nanometre-sized objects; X-ray absorption spectroscopy; microscopy; comparison with neutron scattering, where appropriate.

The generation of high-brilliance x-ray beams at synchrotron radiation sources:
- Undulators, wigglers and bending magnets; comparison with conventional lab sources; the future x-ray free electron laser.

Instrumentation:
- Monochromator; diffractometer; detector.

Determination of materials properties:
- Crystal structure; defects and strain fields; structure of surfaces and interfaces; chemical bonding properties.

New methods:
- Coherent x-ray scattering and diffractive imaging.

Prerequisites / notice
- Course format:
  - Lectures and Mini-Review presentations: Thursday 10-13, ML F 36
  - Homework: Mini-Reviews
  - Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

402-0890-00L Introduction to Computational Physics
- W 8 credits 2V+2U
- H. J. Herrmann

Abstract
- This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions

Content

Prerequisites / notice
- Lecture and exercise lessons in english, exams in German or in English

529-0947-00L Basic Polymer Synthesis
- W 6 credits 3G
- A. D. Schlüter

Abstract
- Chain-growth polymerizations (anionic, cationic, Ziegler/Natta, ROMP, radical, NMP, ATRP), mechanistic details including how to render a polymerization "living", recent developments, and important examples.

Objective
- The students should gain an overview of important polymerization procedures, learn how to deal with chemical structures and reactivities, and be able to suggest reasonable synthetic pathways to a given polymer structure. Aspects like achievable molar masses in dependence of the method used and structure perfection play a role throughout.
I. Anionic polymerization

1. General
2. Living polymerization
3. Group transfer polymerization (GTP)
4. Some recent developments

II. Cationic polymerization

1. General
2. Some applications (macromonomer and telechelics)

III. Ziegler/Natta- and metallocene polymerization

1. General
2. Mechanism
3. Some applications

IV. Ring-opening metathesis polymerization

1. Comments on history
2. Monomers, catalysts, polymer structures
3. Mechanism, direct NMR monitoring
4. Termination
5. Examples

V. Controlled radical polymerization

1. Nitroxide mediated polymerization (NMP)
2. Atom transfer radical polymerization (ATRP)

Lecture notes

A script will not be provided. For all projections shown, however, paper copies will be distributed.

Literature

There is no specific literature recommendation. Numerous references will be provided for an easy access to the original literature.

Prerequisites / notice

The course will be taught in English. Complicated expressions will be explained in German. Questions can be asked in both languages. The examination will be in English; answers are acceptable in both languages.

PhD students who need recognized credit points are required to pass the written exam.

Objective

- The student will actively develop innovative, industrial concepts at the drug-biomaterial interface.
- The student will be able to summarize the current concepts and challenges for the industry at the material-drug interface.
- The student will be able to categorize a drug-biomaterial as a "drug" or a "material" from a regulatory perspective and can summarize general regulatory pathways for material/drug development.
- The student will become familiar with the major elements required for a successful development and which challenges have to be taken into account to translate an idea into a successful product.

Abstract

In Physics of Food Colloids the principles of colloid science will applied to the aggregation of food materials based on proteins, polysaccharides, and emulsifiers. Mixtures of such raw material determine the appearance and performance of our daily food. In a number of examples, colloidal laws are linked to food science and the manufacturing and processing of food.

Content

Lectures include interfacial tension (4h), protein aggregation in bulk and interfaces (4h), Pickering emulsions (2h), gels (4h), aggregation of complex mixtures (4h), and the use of light scattering in investigation complex food structures (6h). Most chapters include some hand-on examples of the gain knowledge to common food products.

Lecture notes

Notes will be handed out during the lectures.

Literature

Provided in the lecture notes.

Objective

- This course will provide an up-to-date, comprehensive review of the industrial perspective at the interface of biomaterials and drugs. This covers regulatory, clinical, pre-clinical and manufacturing concepts. The presentations are provided in an effort to maximize the interaction of student and lecturer.
- The student will be able to categorize a drug-biomaterial as a "drug" or a "material" from a regulatory perspective and can summarize general regulatory pathways for material/drug development.
- The student will be able to summarize the current concepts and challenges for the industry at the material-drug interface.
- The student will actively develop innovative, industrial concepts at the drug-biomaterial interface.
- The student will become familiar with the major elements required for a successful development and which challenges have to be taken into account to translate an idea into a successful product.

Abstract

This course will provide an up-to-date, comprehensive review of the industrial perspective at the interface of biomaterials and drugs. General concepts related to regulatory affairs or such as cost-conscious planning of manufacturing processes will be covered by interactive case-studies and in close interaction between students and lecturers. The course covers the future at the biomaterial - implant interface - as it is seen by the industry today - and will be reviewed by experienced and long-standing faculty from industry with the aim to provide a balanced, insightful perspective. From that, clinical development concepts, regulatory pathways and real-life case studies will be discussed with the students. Finally the students - working in small groups of 4-5 - will outline a development pathway for an industrial project and present it to the course and in presence of all faculty to receive maximum feedback to their approaches.

The student will become familiar with the major elements required for a successful development and which challenges have to be taken into account to translate an idea into a successful product.

Objective

The course addresses undergraduate and graduate students interested in getting introduced into the basic concepts of biomineralization. The course aims to introduce the basic concepts of biomineralization and the underlying principles, such as supersaturation, nucleation and growth of minerals, the interaction of biomolecules with mineral surfaces, and cell biology of inorganic materials creation. An important part of this class is the independent study and the presentation of original literature from the field.

Abstract

The course will provide an up-to-date comprehensive review of the industrial perspective at the interface of biomaterials and drugs. This covers regulatory, clinical, pre-clinical and manufacturing concepts. The presentations are provided in an effort to maximize the interaction of student and lecturer.
### Content

Biomineralization is a multidisciplinary field. Topics dealing with biology, molecular and cell biology, solid state physics, mineralogy, crystallography, organic and physical chemistry, biochemistry, dentistry, oceanography, geology, etc. are addressed. The course covers definition and general concepts of biomineralization (BM)/ types of biominerals and their function / crystal nucleation and growth / biological induction of BM / control of crystal morphology, habit, shape and orientation by organisms / strategies of compartmentalization / the interface between biomolecules (peptides, polysaccharides) and the mineral phase / modern experimental methods for studying BM phenomena / inter-, intra, extra- and epipellular BM / organic templates and matrices for BM / structure of bone, teeth (vertebrates and invertebrates) and mollusk shells / calcification / siliification in diatoms, radiolaria and plants / calcium and iron storage / impact of BM on lithosphere and atmosphere/ evolution / taxonomy of organisms.

1. Introduction and overview
2. Biominerals and their functions
3. Chemical control of biomineralization
4. Control of morphology: Organic templates and additives
5. Modern methods of investigation of BM
6. BM in matrices: bone and nacre
7. Vertebrate teeth
8. Invertebrate teeth
9. BM within vesicles: calcite of coccoliths
10. Silica
11. Iron storage and mineralization

### Lecture notes

Script with more than 600 pages with many illustrations will be distributed free of charge.

### Literature


### Prerequisites / notice

No special requirements are needed for attending. Basic knowledge in chemistry and cell biology is expected.

### 327-2125-00L  
Microscopy Training SEM I - Introduction to SEM  
Number of participants limited to 6.

The participants will be chosen based on a short motivation letter. Please send this letter to S. Rodighiero (main lecturer) as soon as possible.

<table>
<thead>
<tr>
<th>Objective</th>
</tr>
</thead>
</table>
| - Set-up, align and operate a SEM successfully and safely.  
- Accomplish imaging tasks successfully and optimize microscope performances.  
- Master the operation of a low-vacuum and field-emission SEM and EDX instrument.  
- Perform sample preparation with corresponding techniques and equipment for imaging and analysis  
- Acquire techniques in obtaining secondary electron and backscatter electron micrographs  
- Perform EDX qualitative and semi-quantitative analysis | 
| Content | 
| - Discussion of students' sample/interest  
- Introduction and discussion on Electron Microscopy and instrumentation  
- Lectures on electron sources, electron lenses and probe formation  
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.  
- Lectures on sample preparation techniques for EM  
- Brief description and demonstration of the SEM microscope  
- Practice on beam/specimen interaction, image formation, image contrast (and image processing)  
- Student participation on sample preparation techniques  
- Scanning Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities  
- Lecture and demonstrations on X-ray micro-analysis (theory and detection), qualitative and semi-quantitative EDX and point analysis, linescans and spectral mapping  
- Practice on real-world samples and report results | 
| Literature | 
| - Detailed course manual  
| Prerequisites / notice | 
| No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite. | 

### 327-2126-00L  
Microscopy Training TEM I - Introduction to TEM  
Number of participants limited to 6.

The participants will be chosen based on a short motivation letter. Please send this letter to S. Rodighiero (main lecturer).

<table>
<thead>
<tr>
<th>Objective</th>
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</thead>
</table>
| - Overview of TEM theory, instrumentation, operation and applications.  
- Alignment and operation of a TEM, as well as acquisition and interpretation of images, diffraction patterns, accomplishing basic tasks successfully.  
- Knowledge of electron imaging modes (including Scanning Transmission Electron Microscopy), magnification calibration, and image acquisition using CCD cameras.  
- To set up the TEM to acquire diffraction patterns, perform camera length calibration, as well as measure and interpret diffraction patterns.  
- Overview of techniques for specimen preparation. | 
| Content | 
| - Perform EDX qualitative and semi-quantitative analysis  
- Acquire techniques in obtaining secondary electron and backscatter electron micrographs  
- Perform sample preparation with corresponding techniques and equipment for imaging and analysis  
- Acquire techniques in obtaining secondary electron and backscatter electron micrographs  
- Perform EDX qualitative and semi-quantitative analysis  
- Discussion of students' sample/interest  
- Introduction and discussion on Electron Microscopy and instrumentation  
- Lectures on electron sources, electron lenses and probe formation  
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.  
- Lectures on sample preparation techniques for EM  
- Brief description and demonstration of the SEM microscope  
- Practice on beam/specimen interaction, image formation, image contrast (and image processing)  
- Student participation on sample preparation techniques  
- Scanning Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities  
- Lecture and demonstrations on X-ray micro-analysis (theory and detection), qualitative and semi-quantitative EDX and point analysis, linescans and spectral mapping  
- Practice on real-world samples and report results | 
| Literature | 
| - Detailed course manual  
| Prerequisites / notice | 
| No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite. |
Content

Using two Transmission Electron Microscopes the students learn how to align a TEM, select parameters for acquisition of images in bright field (BF) and dark field (DF), perform scanning transmission electron microscopy (STEM) imaging, phase contrast imaging, and acquire electron diffraction patterns. The participants will also learn basic and advanced use of digital cameras and digital imaging methods.

- Introduction and discussion on Electron Microscopy and instrumentation.
- Lectures on electron sources, electron lenses and probe formation.
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM.
- Brief description and demonstration of the TEM microscope.
- Practice on beam/specimen interaction, image formation, Image contrast (and image processing).
- Demonstration of Transmission Electron Microscopes and imaging modes (Phase contrast, BF, DF, STEM).
- Student participation on sample preparation techniques.
- Transmission Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.
- TEM alignment, calibration, correction to improve image contrast and quality.
- Electron diffraction.
- Practice on real-world samples and report results.

Literature

- Detailed course manual

Prerequisites / notice

No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-2127-00L</td>
<td>Sustainable Materials Management: Concepts, Methods and Principles</td>
<td>W</td>
<td>1 credit</td>
<td>1V</td>
<td>P. Wäger</td>
</tr>
</tbody>
</table>

Abstract

The aim of this course is to introduce important concepts, methods and principles for sustainable materials management and to critically reflect their possibilities and limitations. A particular focus will be laid on recycling issues.

Objective

Students develop a basic understanding of important concepts, methods and principles for sustainable materials management and become acquainted with their possibilities and limitations.

Content

The course consists of six lectures introducing concepts, methods and principles for a sustainable materials management (including, amongst others, material flow analysis, life cycle assessment, raw materials criticality evaluation), with a particular focus on recycling issues and exemplifications for materials relevant for Information and Communication Technologies (ICT) and emerging energy technologies.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0455-00L</td>
<td>Terahertz: Technology &amp; Applications</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>K. Sankaran</td>
</tr>
</tbody>
</table>

Abstract

This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting.

Objective

This is an introductory course on Terahertz (THz) technology and applications. Devices operating in THz frequency range (0.1 to 10 THz) have been increasingly studied in the recent years. Progress in nonlinear optical materials, ultrafast optical and electronic techniques has strengthened research in THz application developments. Due to unique interaction of THz waves with materials, applications with new capabilities can be developed. In theory, they can penetrate somewhat like X-rays, but are not considered harmful radiation, because THz energy level is low. They should be able to provide resolution as good or better than magnetic resonance imaging (MRI), possibly with simpler equipment. Imaging, very-high bandwidth communication, and energy harvesting are the most widely explored THz application areas. We will study the basics of THz generation, manipulation, and detection. Our emphasis will be on the physical principles and applications of THz in the domain of imaging, communication and energy harvesting.

Content

INTRODUCTION
Chapter 1: Introduction to THz Physics
Chapter 2: Components of THz Technology

THz TECHNOLOGY MODULES
Chapter 3: THz Generation
Chapter 4: THz Detection
Chapter 5: THz Manipulation

APPLICATIONS
Chapter 6: THz Imaging
Chapter 7: THz Communication
Chapter 8: THz Energy Harvesting

Literature

- Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009

Whenever we deviate from the main material discussed in these books, softcopy of lectures notes will be provided.

Good foundation in electromagnetics & knowledge of microwave or optical communication is helpful.

Projects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-1210-00L</td>
<td>Project I</td>
<td>O</td>
<td>12 credits</td>
<td>23A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract

Independent scientific practice of 8 weeks which is completed with a written report. Projects, with themes from the chosen scientific fields of interest, are intended to familiarise candidates with scientific procedures and operational methodologies through supervised participation in current research work.

Objective

Projects, with themes from the chosen scientific fields of interest, are intended to familiarise candidates with scientific procedures and operational methodologies through supervised participation in current research work.

Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-9000-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
This course introduces classical and quantum mechanical concepts for the understanding of material properties from a microscopic point of view. The lectures focus on the static and dynamic properties of crystals, the formation of chemical bonds and electronic bands in molecules, insulators, metals, and semiconductors, and on the thermal and electrical properties that emerge from this analysis.

**Objective**
The composition and microstructures of the most important ceramic materials are introduced. Microstructures and heterogeneous phase equilibria and the properties of the four most important structural ceramics and glass are given. An introduction to fracture mechanics of brittle materials will allow to predict the survival probabilities and life time of components under static and dynamic load.

To achieve a basic understanding for what polymers are like, how one can make them accessible and characterize them and, finally, which properties result from their chemical structure.

**Content**
The basics of the chemical bonds of ceramics and glass will be presented. Heterogenous phase equilibria and the properties of the four most important structural ceramics are given. An introduction to fracture mechanics of brittle materials will allow to predict the survival probabilities and life time of components under static and dynamic load.

This introductory course discusses definitions, introduces types of polyreactions, and compares chain and step-growth polymerizations. It also treats the constitution of homo- and copolymers and networks as well as the configuration and conformation of polymers. Topics of interest are contour length, coil formation, the mobility in polymers, glass temperature, rubber elasticity, molecular weight distribution, energetics of polyreactions, and examples for polyreactions (polyadditions, polycondensations, polymerizations). Selected polymerization mechanisms and procedures are discussed. Some methods of molecular weight determination are introduced.

**Prerequisites / notice**
Both literatures will be made available in the course upon request.

In the first part of the lecture the bases are obtained for structural ceramics.

The second part of this lecture gives an introduction to polymers, their composition and properties.

**Literature**
- Modern Ceramic Engineering; David Richerson, Ed. 2, Dekker, 1992.

**Lecture notes**
For ceramics see: http://www.complex.mat.ethz.ch/education/lectures.html


**Enrolment only for MSc students with a decree declaring this course unit as an additional admission requirement.**

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Objective**
Physical properties and fracture mechanics of brittle materials.

**Abstract**
Introduction to polymers.

**Content**
To achieve a basic understanding for what polymers are like, how one can make them accessible and characterize them and, finally, which properties result from their chemical structure.

**Literature**
- Basic Principles of Materials Physics B; P. Gambardella

**Enrolment only for MSc students with a decree declaring this course unit as an additional admission requirement.**

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Abstract**
This course introduces classical and quantum mechanical concepts for the understanding of material properties from a microscopic point of view. The lectures focus on the static and dynamic properties of crystals, the formation of chemical bonds and electronic bands in molecules, insulators, metals, and semiconductors, and on the thermal and electrical properties that emerge from this analysis.

**Objective**
Understanding the electronic properties of solids is at the heart of modern society and technology. The aim of this course is to provide fundamental concepts that allow the student to relate the microscopic structure of matter and the quantum mechanical behavior of electrons to the macroscopic properties of materials. Beyond fundamental curiosity, such level of understanding is required in order to develop and appropriately describe new classes of materials for future technology applications. By the end of the course the student should have developed a semi-quantitative understanding of basic concepts in solid state physics and be able to appreciate the pertinence of different models to the description of specific material properties.

**Prerequisites / notice**
Both literatures will be made available in the course upon request.

In the first part of the lecture the bases are obtained for structural ceramics.

The second part of this lecture gives an introduction to polymers, their composition and properties.
PART I: Structure of solid matter, real and reciprocal space

The crystal lattice, Bravais lattices, primitive cells and unit cells, Wigner-Seitz cell, primitive lattice vectors, lattice with a basis, examples of 3D and 2D lattices.

Fourier transforms and reciprocal space, reciprocal lattice vectors, Brillouin zones


PART II: Dynamics of atoms in crystals

Lattice vibrations and phonons in 1D, phonon in 1D chains with monoatomic basis, phonon in 1D chains with a diatomic basis, optical and acoustic modes, phase and group velocities, phonon dispersion and eigenvectors. Phonons in 2D and 3D.

Quantum mechanical description of lattice waves in solids, the harmonic oscillator, the concept of phonon, phonon statistics, Bose-Einstein distribution, phonon density of states, Debye and Einstein models, thermal energy, heat capacity of solids.

PART III: Electron states and energy bands in molecules and solids

Electronic properties of materials, classical concepts: electrical conductivity, Hall effect, thermoelectric effects. Drude model. Transition to quantum models and review of quantum mechanical concepts.

Introduction to molecular orbital theory and linear combination of atomic orbitals (LCAO). The H2+ molecule, homonuclear and heteronuclear molecules, benzene, sigma and pi bonds, sp3 and sp2 hybridization. From molecules to periodic crystal structures. The free electron gas: Fermi statistics, Fermi energy and Fermi surface, density of states in k-space and as a function of energy. Inadequacy of the free electron model.


PART IV: Electrical and heat conduction

Dynamics of electrons in energy bands, phase and group velocity, crystal momentum, the effective mass concept, scattering phenomena. The equilibrium and non-equilibrium distribution function for electrons. The Boltzmann equation in the presence of external fields in the relaxation time approximation.

Electrical and thermal conductivities revisited. Electron transport due to electric fields (drift) and concentration gradients (diffusion). Einstein's relations. Transport of heat by electrons, Seebeck effect and thermopower, Peltier effect, thermoelectric cooling, thermoelectric energy conversion.

PART V: Semiconductors: concepts and devices


<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Literature</th>
<th>Notice</th>
</tr>
</thead>
</table>
| will be available. | - H. Ibach, H. Lüth: Solid-State Physics (Springer: 2003), available as eBook from the ETH library, also in German. 
- C. Kittel, Introduction to Solid State Physics (Wiley, 2005), also available in German. | The lecture will be given in English. The script will be available in English. |

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>ECTS</th>
<th>Prerequisites / Notice</th>
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<tr>
<td>327-0506-AAL</td>
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<td>327-0503-AAL</td>
<td>Ceramics I</td>
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<td>327-0603-AAL</td>
<td>Ceramics II</td>
<td>3 credits</td>
<td>E-</td>
<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enroll for this course unit.</td>
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</table>
Understanding of the electrical, dielectric and optical properties of functional ceramics for materials engineers, physicists and electrical engineers. An introduction is given to modern ceramics materials with multiple functions.

Ceramics II covers the basic principles of functional ceramics such as linear and non-linear dielectrics, semiconductors, ionic and mixed ionic-electronic conductors as well as materials aspects of high temperature superconductors. Examples of applications cover the range from piezo-, pyro and opto-electronic materials over sensors and solid oxide fuel cells to squids and fault current limiters with superconducting compounds.

At the end of the course, the students should be able to select the chemistry, design the microstructure and devise processing routes to fabricate functional ceramics for electronic, electromechanical, optical and magnetic applications.

<table>
<thead>
<tr>
<th>Lecture notes</th>
</tr>
</thead>
</table>

Abstract
Physical foundations of single polymer molecules and interacting chains.

Objective
To obtain an understanding of the engineering aspects of structure and properties of solid polymers. Influence of polymer processing on properties of solid polymers.

Content
1. Crystallization of semi-crystalline polymers
2. Glass transition of amorphous polymers
3. Mechanical properties of solid polymers
4. Examples of polymer processing
5. Laboratory exercises

Prerequisites / notice
Computer experiments will use the simple MATLAB programming language and will be made available, if necessary or useful.

| Lecture notes |

Abstract
Principles of polymer technology

Objective
To obtain an understanding of the engineering aspects of structure and properties of solid polymers. Influence of polymer processing on properties of solid polymers.

Content
1. Crystallization of semi-crystalline polymers
2. Glass transition of amorphous polymers
3. Mechanical properties of solid polymers
4. Examples of polymer processing
5. Laboratory exercises

Prerequisites / notice
Computer experiments will use the simple MATLAB programming language and will be made available, if necessary or useful.
doctoral students) CANNOT enrol for this course unit.

Abstract
Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

Objective
Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

Content
Dislocation theory:
Properties of dislocations, motion and kinetics of dislocations, dislocation-dislocation and dislocation-boundary interactions, consequences of partial dislocations, sessile dislocations
Hardening theory:
a. solid solution hardening: case studies in copper-nickel and iron-carbon alloys
b. particle hardening: case studies on aluminium-copper alloys
High temperature plasticity:
thermally activated glide
diffusional creep: Coble, Nabarro-Herring
deformation mechanism maps
Case studies in turbine blades
superplasticity
alloying effects

Lecture notes
https://www.met.mat.ethz.ch/education/lect_scripts

Literature
Gottstein, Physikalische Grundlagen der Materialkunde, Springer Verlag
Haasen, Physikalische Metallkunde, Springer Verlag
Rösler/Harders/Bäker, Mechanisches Verhalten der Werkstoffe, Teubner Verlag
Porter/Easterling, Transformations in Metals and Alloys, Chapman & Hall
Hull/Bacon, Introduction to Dislocations, Butterworth & Heinemann
Courtney, Mechanical Behaviour of Materials, McGraw-Hill

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction to materials selection. Basic knowledge of major metallic materials: aluminium, magnesium, titanium, copper, iron and steel. Selected topics in high temperature materials: nickel and iron-base superalloys, intermetallics and refractory metals.

Objective
Introduction to materials selection. Basic knowledge of major metallic materials: aluminium, magnesium, titanium, copper, iron and steel. Selected topics in high temperature materials: nickel and iron-base superalloys, intermetallics and refractory metals.

Content
This course is divided into five parts:

A. Materials selection
Principles of materials properties maps
Introduction to the 'Materials selector' software package
Case studies

B. Light metals and alloys
Aluminium, magnesium, titanium
Properties and hardening mechanisms
Case studies in technological applications

C. Copper and its alloys

D. Iron and steel
The seven pros for steel
Fine grained steels, heat resistant steels
Steel and corrosion phenomena
Selection and application

E. High temperature alloys
Superalloys: iron, nickel, cobalt
Intermetallics: properties and application

Lecture notes
http://www.met.mat.ethz.ch/education/lect_scripts

Literature
Gottstein, Physikalische Grundlagen der Materialkunde, Springer Verlag
Ashby/Jones, Engineering Materials 1 & 2, Pergamon Press
Ashby, Materials Selection in Mechanical Design, Pergamon Press
Porter/Easterling, Transformations in Metals and Alloys, Chapman & Hall
Bürgel, Handbuch Hochtemperatur-Werkstofftechnik, Vieweg Verlag

Prerequisites / notice
Prerequisites: Metals I

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction of basic concepts for composites with polymer- metal- and ceramic matrix composites; production and properties of composites reinforced with particles, whiskers, short and long fibres; selection criteria, case histories of applications, recycling, future perspectives, and basic concepts for adaptive and functional composites

Objective
Gain an insight into the diversity of opportunities to change the properties of composites, learn about the most important applications and processing techniques

Lecture notes
http://www.met.mat.ethz.ch/education/lect_scripts

Literature
Gottstein, Physikalische Grundlagen der Materialkunde, Springer Verlag
Ashby, Materials Selection in Mechanical Design, Pergamon Press
Porter/Easterling, Transformations in Metals and Alloys, Chapman & Hall
Bürgel, Handbuch Hochtemperatur-Werkstofftechnik, Vieweg Verlag

Prerequisites / notice
Prerequisites: Metals I

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction of basic concepts for composites with polymer- metal- and ceramic matrix composites; production and properties of composites reinforced with particles, whiskers, short and long fibres; selection criteria, case histories of applications, recycling, future perspectives, and basic concepts for adaptive and functional composites

Objective
Gain an insight into the diversity of opportunities to change the properties of composites, learn about the most important applications and processing techniques
1. Introduction
   1.1 What are advanced composites?
   1.2 What are materials by combination?
   1.3 Are composites an idea of today?
   1.4 Delphi foresight
   1.5 Why composites?
   1.6 References for chapter 1

2. Basic modules
   2.1 Particles
   2.2 Short fibres including whiskers
   2.3 Long fibres
   2.4 Matrix materials
     2.4.1 Polymers
     2.4.2 Metals
     2.4.3 Ceramics and glasses
   2.5 References for chapter 2

3. PMC: Polymer Matrix Composites
   3.1 Historical background
   3.2 Types of PMC-laminates
   3.3 Production, processing and machining operation
   3.4 Mechanics of reinforcement, microstructure, interfaces
   3.5 Failure criteria
   3.6 Fatigue behaviour of a multiply composite
   3.7 Adaptive materials systems
   3.8 References for chapter 3

4. MMC: Metal matrix composites
   4.1 Introduction: Definitions, selection criteria und "design"
   4.2 Types von MMCs - examples und typical properties
   4.3 Mechanical and physical properties of MMCs - basics of design, influencing variables and damage mechanisms
   4.4 Production processes
   4.5 Micro structure / interfaces
   4.6 machining operations for MMC
   4.7 Applications
   4.8 References for chapter 4

5. CMC: Ceramic Matrix Composites
   5.1 Introduction and historical background
   5.2 Modes of reinforcement
   5.3 Production processes
   5.4 Mechanisms of reinforcement
   5.5 Micro structure / interfaces
   5.6 Properties
   5.7 Applications
   5.8 Materials testing and quality assurance
   5.9 References for chapter 5

Lecture notes
The script will be delivered at the begin of the semester

Literature
The script is including a comprehensive list of references

Prerequisites / notice
Before each class, students will get a handout. Students will get the power point presentation of each class by e-mail.

The exercises take place in small groups. It is their goal to deepen knowledge gained in the classes

written end of semester examination

Materials Science Master - Key for Type

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Key for Hours

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<td>G</td>
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<tr>
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<td>colloquium</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and duration matching, valuation portfolio and loose coupling). The profit and loss account and the balance sheet of a life insurance company is explained and illustrated. Apart from that the most important terms such as mathematical reserves are introduced and calculated.

Investment returns are an important source of funding for social and pension insurance, and financial risk is an important threat to stability. We study short-term and long-term financial risk and its interplay with other risk factors, and we develop methods for the measurement and management of financial risk and return in an asset/liability context with the goal of ensuring sustainable funding.

The profit and loss account and the balance sheet of a life insurance company is explained and illustrated.

The exams ONLY take place during the official ETH examination period.

This course will be held in English and counts towards the diploma of "Aktuar SAV". For the latter, see details under www.actuaries.ch.

Prerequisites: knowledge of probability theory, statistics and applied stochastic processes.

Financial Risk Management in Social and Pension Insurance

Abstract

Investment returns are an important source of funding for social and pension insurance, and financial risk is an important threat to stability. We study short-term and long-term financial risk and its interplay with other risk factors, and we develop methods for the measurement and management of financial risk and return in an asset/liability context with the goal of ensuring sustainable funding.

Objective

Understand the conditions for sustainable funding: derivation of required returns; interplay between return levels, contribution levels and other parameters; influence of guaranteed benefits.

Understand the notion of risk-taking capability: capital process as a random walk; measures of long-term risk and relation to capital; short-term solvency vs. long-term stability; effect of embedded options and guarantees; interplay between required return and risk-taking capability.

Be able to study empirical properties of financial assets: the Normal hypothesis and the deviations from it; statistical tools for investigating relevant risk and return properties of financial assets; time aggregation properties; be able to conduct analysis of real data for the most important asset classes.

Understand and be able to carry out portfolio construction: the concept of diversification; limitations to diversification / correlation breakdown / what happened in 2008; the Kuhn-Tucker Theorem and optimization (mean-variance, mean-downside); incorporation of constraints; sensitivity and shortcomings of optimized portfolios.

Understand and interpret the asset-liability interplay: the optimized portfolio in the asset-liability framework; short-term risk vs. long-term risk; the influence of constraints; feasible and non-feasible solutions; practical considerations.

Know about active portfolio management: practical issues when implementing an investment strategy; the notion of active management; efficient markets hypothesis and limitations to it; empirical evidence; the fundamental law of active management; Bayesian concepts and the Black-Litterman framework.

Have an overall view; see the big picture of what asset returns can and cannot contribute to social security; be aware of the most relevant outcomes; know the role of the actuary in the financial risk management process.
For pension insurance and other forms of social insurance, investment returns are an important source of funding. In order to earn these returns, substantial financial risks must be taken, and these risks represent an important threat to financial stability in the long term and in the short term.

Risk and return of financial assets cannot be separated from one another and, hence, asset management and risk management cannot be separated either. Managing financial risk in social and pension insurance is, therefore, the task of reconciling the contradictory dimensions of

1. Required return for a sustainable funding of the institution,
2. Risk-taking capability of the institution,
3. Returns available from financial assets in the market,
4. Risks incurred by investing in these assets.

This task must be accomplished under a number of constraints. Financial risk management in social insurance also means reconciling the long time horizon of the promised insurance benefits with the short time horizon of financial markets and financial risk.

It is not the goal of this lecture to provide the students with any cookbook recipes that can readily be applied without further reflection. The goal is rather to enable the students to develop their own understanding of the problems and possible solutions associated with the management of financial risks in social and pension insurance.

To this end, a rigorous intellectual framework will be developed and a powerful set of mathematical tools from the fields of actuarial mathematics and quantitative risk management will be applied. When analyzing the properties of financial assets, an empirical viewpoint will be taken using statistical tools and considering real-world data.

Since this is the first instance of this course, there is not yet a full script. However, to complement the blackboard notes, extensive handouts will be provided. Moreover, practical examples and data sets in Excel and Octave / Matlab will be made available to play around with and deepen the understanding of the subject matter.

Solid base knowledge of probability and statistics is indispensable. Specialized concepts from financial and insurance mathematics as well as quantitative risk management will be introduced in the lecture as needed, but some prior knowledge in some of these areas would be an advantage.

This course counts towards the diploma of "Aktuar SAV".

The exams ONLY take place during the official ETH examination period.

### 401-3913-01L Mathematical Foundations for Finance

**Abstract**

First introduction to main modelling ideas and mathematical tools from mathematical finance

**Objective**

This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

**Content**

Topics to be covered include

- financial market models in finite discrete time
- absence of arbitrage and martingale measures
- valuation and hedging in complete markets
- basics about Brownian motion
- stochastic integration
- stochastic calculus: Itô's formula, Girsanov transformation, Itô's representation theorem
- Black-Scholes formula

**Lecture notes**

Lecture notes will be provided at the beginning of the course.

**Literature**

Lecture notes will be provided at the beginning of the course. Additional (background) references are given there.

**Prerequisites / notice**

Prerequisites: Results and facts from probability theory as in the book "Probability Essentials" by J. Jacod and P. Protter will be used freely. Especially participants without a direct mathematics background are strongly advised to familiarise themselves with those tools before (or very quickly during) the course. (A possible alternative to the above English textbook are the (German) lecture notes for the standard course "Wahrscheinlichkeitstheorie").

For those who are not sure about their background, we suggest to look at the exercises in Chapters 8, 9, 22-25, 28 of the Jacod/Protter book. If these pose problems, you will have a hard time during the course. So be prepared.

### 363-0565-00L Principles of Macroeconomics

**Abstract**

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?

**Objective**

This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to every-day economic problems.

**Content**

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

**Lecture notes**

The course webpage (to be found at [https://moodle-app2.let.ethz.ch/course/view.php?id=2467](https://moodle-app2.let.ethz.ch/course/view.php?id=2467)) contains announcements, course information and lecture slides.

**Literature**


We advise you to also buy access to Apila. This internet platform will support you in learning for this course. To save money, you should buy the book together with Apila. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.
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<th>Key for Type</th>
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<th>W</th>
<th>E-</th>
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### Key for Hours

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**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Mathematics Bachelor

**Bachelor Studies (Programme Regulations 2016)**

#### First Year

**First Year Compulsory Courses**

**Minor Courses**

**GESS Science in Perspective**

#### First Year Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
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<td>401-1151-00L</td>
<td>Linear Algebra I</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>M. Akveld</td>
</tr>
</tbody>
</table>
| Objective    | - Mastering basic concepts of Linear Algebra
- Introduction to mathematical methods
- Basics
- Vector spaces and linear maps
- Systems of linear equations and matrices
- Determinants
- Endomorphisms and eigenvalues
| Content      | Abstract            |
| 402-1701-00L | Physics I           | O    | 7     | 4V+2U | A. Wallraff       |
| Abstract     | This course gives a first introduction to Physics. The emphasis is on classical mechanics, together with an introduction to thermodynamics. |
| Objective    | Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems. |
| Content      | Abstract            |
| 252-0847-00L | Computer Science    | O    | 5     | 2V+2U | B. Gärtner        |
| Abstract     | This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications. |
| Objective    | The goal of this lecture is an algorithmically oriented introduction to programming. |
| Content      | Abstract            |
| Literature   | Lecture notes in English and Handouts in German will be distributed electronically along with the course. |

#### First Year Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>401-1261-07L</td>
<td>Analysis I</td>
<td>O</td>
<td>10</td>
<td>6V+3U</td>
<td>M. Einsiedler</td>
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<tr>
<td>Abstract</td>
<td>Introduction to the differential and integral calculus in one real variable: fundamentals of mathematical thinking, numbers, sequences, basic point set topology, continuity, differentiable functions, ordinary differential equations, Riemann integration.</td>
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<tr>
<td>Objective</td>
<td>The ability to work with the basics of calculus in a mathematically rigorous way.</td>
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Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1108 of 1571
Bachelor Studies (Programme Regulations 2010)

First Year

Course Units of the first year can be found in section Bachelor Studies (Programme Regulations 2016) - First Year.

Compulsory Courses

Examination Block I

In Examination Block I either the course unit 402-2883-00L Physics III or the course unit 402-2203-01L Classical Mechanics must be chosen and registered for an examination. (Students may also enrol for the other of the two course units; within the ETH Bachelor's programme in mathematics, this other course unit cannot be registered in myStudies for an examination nor can it be recognised for the Bachelor's degree.)

<table>
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<td>401-2303-00L</td>
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<td>O</td>
<td>6</td>
<td>3+2</td>
<td>R. Pandharipande</td>
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<td></td>
<td>Abstract</td>
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<tr>
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<td>Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, analytic continuation, special functions, conformal mappings, Riemann mapping theorem.</td>
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<tr>
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<td>Working Knowledge with functions of one complex variables; in particular applications of the residue theorem</td>
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<td></td>
<td>Th. Gamelin: Complex Analysis. Springer 2001</td>
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<td></td>
<td>D. Salamon: &quot;Funktionentheorie&quot;. Birkhauser, 2011. (In German)</td>
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<td>B. Palka: &quot;An introduction to complex function theory.&quot;</td>
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<td>R. Remmert: Theory of Complex Functions. Springer Verlag</td>
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</tbody>
</table>

| 401-2333-00L | Methods of Mathematical Physics I | O    | 6    | 3+2   | C. A. Keller |
|              | Abstract                     |      |      |       |                |
|              | Prerequisites / notice        |      |      |       |                |

| 402-2883-00L | Physics III                  | W    | 7    | 4+2   | J. Home |
|              | Abstract                     |      |      |       |        |
|              | Introductory course on quantum and atomic physics including optics and statistical physics. |
|              | Objective                    |      |      |       |        |
|              | A basic introduction to quantum and atomic physics, including basics of optics and equilibrium statistical physics. The course will focus on the relation of these topics to experimental methods and observations. |
|              | Content                      |      |      |       |        |
|              | Evidence for Quantum Mechanics: atoms, photons, photo-electric effect, Rutherford scattering, Compton scattering, de-Broglie waves. |
|              | Quantum mechanics: wavefunctions, operators, Schrodinger's equation, infinite and finite square well potentials, harmonic oscillator, hydrogen atoms, spin. |
|              | Atomic structure: Perturbation to basic structure, including Zeeman effect, spin-orbit coupling, many-electron atoms. X-ray spectra, optical selection rules, emission and absorption of radiation, including lasers. |
|              | Optics: Fermat's principle, lenses, imaging systems, diffraction, interference, relation between geometrical and wave descriptions, interferometers, spectrometers. |
|              | Statistical mechanics: probability distributions, micro and macrostates, Boltzmann distribution, ensembles, equipartition theorem, blackbody spectrum, including Planck distribution. |
|              | Lecture notes                |      |      |       |        |
|              | Lecture notes will be provided electronically during the course. |
402-2203-01L Classical Mechanics
W 7 credits 4V+2U G. M. Graf

Abstract
A conceptual introduction to theoretical physics: Newtonian mechanics, central force problems, oscillations, Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.

252-0851-00L Algorithms and Complexity
O 4 credits 2V+1U A. Steger

Abstract
Introduction: RAM machine, data structures; Algorithms: sorting, median, matrix multiplication, shortest paths, minimal spanning trees; Paradigms: divide & conquer, dynamic programming, greedy algorithms; Data Structures: search trees, dictionaries, priority queues; Complexity Theory: P and NP, NP-completeness, Cook's theorem, reductions.

Objective
After this course students know some basic algorithms as well as underlying paradigms. They will be familiar with basic notions of complexity theory and can use them to classify problems.

Content

Lecture notes
Ja. Wird zu Beginn des Semesters verteilt.

Examination Block II

Core Courses

Core Courses: Pure Mathematics

401-3531-00L Differential Geometry I
W 10 credits 4V+1U U. Lang

Abstract
This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from neither 401-3531-00L Differential Geometry I nor 401-3532-00L Differential Geometry II for their Bachelor's degree still can have recognised this course for the Master's degree. Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I, 401-3531-00L Differential Geometry I, 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.

Objective
Introduction to elementary differential geometry and differential topology.

Content
- Differential geometry in R^n: theory of curves, submanifolds and immersions, inner geometry of hypersurfaces, Gauss map and curvature, Theorema Egregium, special classes of surfaces, Gauss-Bonnet theorem, hyperbolic space, differentiable manifolds, tangent bundle, immersions and embeddings, Sard's Theorem, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.
- The hyperbolic space.
- Differential topology: differentiable manifolds, tangent bundle, immersions and embeddings in R^n, Sard's Theorem, transversality, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.

Literature
- B. P. do Carmo: Differential geometry of curves and surfaces
- W. K. Kühnel: Differential geometry. Curves-surfaces-manifolds
- C. Bär: Elementary differential geometry

401-3461-00L Functional Analysis I
W 10 credits 4V+1U M. Struwe

Abstract
This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from neither 401-3461-00L Functional Analysis I nor 401-3462-00L Functional Analysis II for their Bachelor's degree still can have recognised this course for the Master's degree in Mathematics or Applied Mathematics.

Objective
Introduction and development of some basic algebraic structures - groups, rings, fields.

Content
After this course students know some basic algorithms as well as underlying paradigms. They will be familiar with basic notions of complexity theory and can use them to classify problems.

Literature
- L. Halbeisen: A Course in Group Theory (Oxford University Press)
- J. F. Humphreys: A Course in Group Theory (Oxford University Press)
- G. Smith and O. Tabachnikova: Topics in Group Theory (Springer-Verlag)
- B. L. van der Waerden: Algebra I & II (Springer-Verlag)
Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I, 401-3531-00L Differential Geometry I, or 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.

Abstract
Baire category; Banach and Hilbert spaces, bounded linear operators; three fundamental principles: Uniform boundedness, open mapping/closed graph theorem, Hahn-Banach; convexity; dual spaces; weak and weak* topologies; Banach-Alaoglu; reflexive spaces; compact operators and Fredholm theory; closed range theorem; spectral theory of self-adjoint operators in Hilbert spaces.

Lecture notes
Lecture Notes on "Funktionalanalysis I" by Michael Struwe

401-3371-00L Dynamical Systems I
Abstract
This course is a broad introduction to dynamical systems. Topic covered include topological dynamics, ergodic theory and low-dimensional dynamics.

Objective
Mastery of the basic methods and principal themes of some aspects of dynamical systems.

Content
Topics covered include:
1. Topological dynamics (transitivity, attractors, chaos, structural stability)
2. Ergodic theory (Poincaré recurrence theorem, Birkhoff ergodic theorem, existence of invariant measures)
3. Low-dimensional dynamics (Poincaré rotation number, dynamical systems on [0,1])

Literature
The most relevant textbook for this course is Introduction to Dynamical Systems, Brin and Stuck, CUP, 2002.

Prerequisites / notice
The material of the basic courses of the first two years of the program at ETH is assumed. In particular, you should be familiar with metric spaces and elementary measure theory.

401-3001-61L Algebraic Topology I
Abstract
This is an introductory course in algebraic topology. The course will cover the following main topics: introduction to homotopy theory, homology and cohomology of spaces.

Literature

Book can be downloaded for free at:
http://www.math.cornell.edu/%7ehatcher/AT/ATpage.html

See also:
http://www.math.cornell.edu/%7ehatcher/#anchor1772800
3) E. Spanier, "Algebraic topology", Springer-Verlag

General topology, linear algebra.

Prerequisites / notice
Some knowledge of differential geometry and differential topology is useful but not absolutely necessary.

401-3132-00L Commutative Algebra
Abstract
This course provides an introduction to commutative algebra as a foundation for and first steps towards algebraic geometry. The material in this course will be assumed in the lecture course "Algebraic Geometry" in the spring semester 2017.

Objective
We shall cover approximately the material from
--- most of the textbook by Atiyah-MacDonald, or
--- the first half of the textbook by Bosch.
Topics include:
* Basics about rings, ideals and modules
  * Localization
  * Primary decomposition
  * Integral dependence and valuations
  * Noetherian rings
  * Completions
  * Basic dimension theory

Literature

Prerequisites / notice
Prerequisites: Algebra I (or a similar introduction to the basic concepts of ring theory).

Core Courses: Pure Mathematics (Mathematics Master)

Core Courses: Applied Mathematics and Further Appl.-Oriented Fields
vollständiger Titel:
Kernfächer aus Bereichen der angewandten Mathematik und weiteren anwendungsorientierten Gebieten

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>401-3651-00L</td>
<td>Numerical Methods for Elliptic and Parabolic Partial</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>C. Schwab</td>
</tr>
</tbody>
</table>
Differential Equations
Course audience at ETH: 3rd year ETH BSc Mathematics and MSc Mathematics and MSc Applied Mathematics students.
Other ETH-students are advised to attend the course "Numerical Methods for Partial Differential Equations" (401-0674-00L) in the CSE curriculum during the spring semester.

Abstract
This course gives a comprehensive introduction into the numerical treatment of linear and non-linear elliptic boundary value problems, related eigenvalue problems and linear, parabolic evolution problems. Emphasis is on theory and the foundations of numerical methods. Practical exercises include MATLAB implementations of finite element methods.

Objective
Participants of the course should become familiar with
* concepts underlying the discretization of elliptic and parabolic boundary value problems
* analytical techniques for investigating the convergence of numerical methods for the approximate solution of boundary value problems
* methods for the efficient solution of discrete boundary value problems
* implementational aspects of the finite element method

Content
A selection of the following topics will be covered:

* Elliptic boundary value problems
* Galerkin discretization of linear variational problems
* The primal finite element method
* Mixed finite element methods
* Discontinuous Galerkin Methods
* Boundary element methods
* Spectral methods
* Adaptive finite element schemes
* Singularly perturbed problems
* Sparse grids
* Galerkin discretization of elliptic eigenproblems
* Non-linear elliptic boundary value problems
* Discretization of parabolic initial boundary value problems

Lecture notes
Course slides will be made available to the audience.

Literature
n.a.

Prerequisites / notice
Practical exercises based on MATLAB

401-3601-00L Probability Theory
W 10 credits 4V+1U A.S. Sznitman

This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from none of the three course units 401-3601-00L Probability Theory, 401-3642-00L Brownian Motion and Stochastic Calculus resp. 401-3662-00L Applied Stochastic Processes for their Bachelor's degree still can have recognised this course for the Master's degree. Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.

Abstract
Basics of probability theory and the theory of stochastic processes in discrete time

Objective
This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:

Basic in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.

Content
This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:

Basic in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.

Lecture notes
available, will be sold in the course

Literature
H. Bauer, Probability Theory, de Gruyter 1996
J. Jacod and P. Protter, Probability essentials, Springer 2004
A. Klenke, Wahrscheinlichkeitstheorie, Springer 2006
D. Williams, Probability with martingales, Cambridge University Press 1991

401-3621-00L Fundamentals of Mathematical Statistics
W 10 credits 4V+1U F. Balabdaoui

The course covers the basics of inferential statistics.

425-0057-00L Theoretical Computer Science
W 8 credits 4V+2U+1A J. Hromkovic

Concepts to cope with: a) what can be accomplished in a fully automated fashion (algorithmically solvable) b) How to measure the inherent difficulty of tasks (problems) c) What is randomness and how can it be useful? d) What is nondeterminism and what role does it play in CS? e) How to represent infinite objects by finite automata and grammars?

Objective
Learning the basic concepts of computer science along their historical development
This lecture gives an introduction to theoretical computer science, presenting the basic concepts and methods of computer science in its historical context. We present computer science as an interdisciplinary science which, on the one hand, investigates the border between the possible and the impossible and the quantitative laws of information processing, and, on the other hand, designs, analyzes, verifies, and implements computer systems.

The main topics of the lecture are:

- alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks
- finite automata, regular and context-free grammars
- Turing machines and computability
- complexity theory and NP-completeness
- design of algorithms for hard problems

Lecture notes
The lecture is covered in detail by the textbook "Theoretical Computer Science".

Further reading:

More exercises and examples in:
6. A. Aseroth, Ch. Baier: Theoretische Informatik

Prerequisites / notice
During the semester, two non-obligatory test exams will be offered.

Core Courses: Further Application-Oriented Fields

402-0205-00L Quantum Mechanics I is eligible as an applied core course, but only if 402-0224-00L Theoretical Physics (offered for the last time in FS 2016) isn’t recognised for credits (neither in the Bachelor’s nor in the Master’s programme).

For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

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<tbody>
<tr>
<td>402-0205-00L</td>
<td>Quantum Mechanics I</td>
<td>W</td>
<td>10</td>
<td>3V+2U</td>
<td>T. K. Gehrmann</td>
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</table>

Abstract
Introduction to non-relativistic single-particle quantum mechanics. In particular, the basic concepts of quantum mechanics, such as the quantisation of classical systems, wave functions and the description of observables as operators on a Hilbert space, and the formulation of symmetries will be discussed. Basic phenomena will be analysed and illustrated by generic examples.

Objective
Introduction to single-particle quantum mechanics. Familiarity with basic ideas and concepts (quantisation, operator formalism, symmetries, perturbation theory) and generic examples and applications (bound states, tunneling, scattering states, in one- and three-dimensional settings). Ability to solve simple problems.

Content
Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), symmetries (translations, rotations), quantum mechanics in one dimension, spherically symmetric problems in three dimensions, scattering theory, perturbation theory, variational techniques, spin, addition of angular momenta, relation between QM and classical physics.

Literature
F. Schwabi: Quantum mechanics
J.J. Sakurai: Modern Quantum Mechanics
C. Cohen-Tannoudji: Quantum mechanics I

Electives

Selection: Algebra, Topology, Discrete Mathematics, Logic

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<tr>
<th>Number</th>
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<tr>
<td>401-3117-66L</td>
<td>Introduction to the Circle Method</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

Abstract
The circle method, invented by Hardy and Ramanujan and developed by Hardy and Littlewood and Kloosterman, is one of the most versatile methods currently available to determine the asymptotic behavior of the number of integral solutions to polynomial equations, when the number of solutions is sufficiently large.

Content
The circle method, invented by Hardy and Ramanujan and developed by Hardy and Littlewood and Kloosterman, is one of the most versatile methods currently available to determine the asymptotic behavior of the number of integral solutions to polynomial equations, when the number of solutions is sufficiently large. The lecture will present an introduction to this method. In particular, it will present the solution of Waring's Problem concerning the representability of integers as sums of a bounded numbers of (fixed) powers of integers.

Literature
H. Davenport, "Analytic methods for Diophantine equations and Diophantine inequalities", Cambridge
H. Iwaniec and E. Kowalski, "Analytic number theory", chapter 20; AMS
**Riemann Surfaces (Part 2)**

The goal of the course is to study several classical and important (and beautiful!) topics in group and representation theory, that are otherwise often overlooked in a standard curriculum.

In particular, we plan to study reflection and Coxeter groups, classical invariant theory, and the theory of real semi simple Lie algebras and their representations.

**Finite geometries I, II:** Finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler's thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closed theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Moebius planes, error correcting codes, block design.

Despite the title, the course will begin by a recollection of basic concepts of group and representation theory, in particular that of finite groups and Lie groups.

Hence the course should be accessible also for students who only had a brief exposure to representation theory, as for example in the MMP course.

- Max Jeger, Endliche Geometrien, ETH Skript 1988
- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II. Bibliographisches Institut 1983
- Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press
- Dembowski: Finite Geometries.

### Selection: Geometry

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>401-3057-00L</td>
<td>Finite Geometries II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
</tbody>
</table>

**Abstract:** Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.

**Objective:** Students will be able to construct and analyze models of finite geometries. They are familiar with closing theorems of the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design.

**Content:** Finite geometries I, II: finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler’s thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Moebius planes, error correcting codes, block design.

### Selection: Analysis

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<tr>
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<tbody>
<tr>
<td>401-3303-00L</td>
<td>Special Topics in One Complex Variable</td>
<td>W</td>
<td>6</td>
<td>3V</td>
<td>H. Knörrer</td>
</tr>
</tbody>
</table>

**Abstract:** Hypergeometric Functions, Boundary values of holomorphic functions, Nevanlinna Theory and other special topics.

**Objective:** Advanced methods of one complex variables

**Literature:**
- R. Remmert: Funktionentheorie II. Springer Verlag
- C.Carathéodory: Funktionentheorie. Birkhäuser
- E.Hille: Analytic Function Theory. AMS Chelsea Publishing
- A.Gogolin: Komplexe Integration. Springer

**Prerequisites / notice:**
- Knowledge of complex analysis and some knowledge of real analysis.

### Selection: Numerical Analysis

**no course offer**

### Selection: Probability Theory, Statistics

<table>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>401-3604-66L</td>
<td>Special Topics in Probability: Recent Developments in Percolation Theory</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>P. Nolin</td>
</tr>
</tbody>
</table>

**Abstract:** The goal of this course is to present recent developments in Percolation Theory

**Objective:** The goal of this course is to present recent developments in Percolation Theory
Content

Independent percolation is obtained by deleting randomly (and independently) the edges of a lattice, each with a given probability p between 0 and 1. One is then interested in the connectivity properties of the random subgraph so-obtained. It is arguably the simplest model from statistical mechanics that displays a phase transition, a drastic change of behavior as the parameter p varies.

We will first present classical tools and properties of percolation theory: in particular correlation inequalities, exponential decay of connection probabilities, and uniqueness of the infinite connected component. We will then discuss recent developments: for example percolation on Cayley graphs, and continuum limits in two dimensions.

Literature

B. Bollobas, O. Riordan: Percolation, CUP 2006

Prerequisites / notice

Prerequisites:

401-2604-00L Probability and Statistics (mandatory)
401-3601-00L Probability Theory (recommended)

401-3627-00L High-Dimensional Statistics

Abstract

“High-Dimensional Statistics” deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.

Objective

Knowledge of methods and basic theory for high-dimensional statistical inference

Content

Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling

Literature


Prerequisites / notice

Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

401-4623-00L Time Series Analysis

Abstract

Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Objective

Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

Content

This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

Lecture notes

Not available

Literature

A list of references will be distributed during the course.

401-0625-01L Applied Analysis of Variance and Experimental Design

Abstract


Objective

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content


Literature


Prerequisites / notice

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.

401-3611-00L Advanced Topics in Computational Statistics

Abstract

This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.

Objective

Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

Content

The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

Lecture notes

Lecture notes.

Prerequisites / notice

Knowledge of a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

401-0649-00L Applied Statistical Regression

Abstract

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

Objective

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content

The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

A script will be available.

Literature

Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

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The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

## Selection: Financial and Insurance Mathematics

In the Bachelor's programme in Mathematics 401-3913-01L Mathematical Foundations for Finance is eligible as an elective course, but only if 401-3988-00L Introduction to Mathematical Finance isn't recognised for credits (neither in the Bachelor's nor in the Master's programme). For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

### Prerequisites / notice

The exams ONLY take place during the official ETH examination period.

This course will be held in English and counts towards the diploma of “Aktuar SAV”. For the latter, see details under www.actuaries.ch.

Prerequisites: knowledge of probability theory, statistics and applied stochastic processes.

### 401-3922-00L Life Insurance Mathematics

**Abstract**

The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and endowment insurance and disability). Besides that the most important terms such as mathematical reserves are introduced and calculated. The profit and loss account and the balance sheet of a life insurance company is explained and illustrated.

**Objective**

The student is familiar with the basics in non-life insurance mathematics and statistics. This includes the basic mathematical models for insurance liability modeling, pricing concepts, stochastic claims reserving models and ruin and solvency considerations.

**Content**

The following topics are treated:
- Collective Risk Modeling
- Individual Claim Size Modeling
- Approximations for Compound Distributions
- Ruin Theory in Discrete Time
- Premium Calculation Principles
- Tariffication and Generalized Linear Models
- Bayesian Models and Credibility Theory
- Claims Reserving
- Solvency Considerations

**Lecture notes**

M. V. Wüthrich, Non-Life Insurance: Mathematics & Statistics

http://ssrn.com/abstract=2319328

### 401-3929-00L Financial Risk Management in Social and Pension Insurance

**Abstract**

Investment returns are an important source of funding for social and pension insurance, and financial risk is an important threat to stability. We study short-term and long-term financial risk and its interplay with other risk factors, and we develop methods for the measurement and management of financial risk and return in an asset/liability context with the goal of assuring sustainable funding.

**Objective**

Understand the basic asset-liability framework: essential principles and properties of social and pension insurance; cash flow matching, duration matching, valuation portfolio and loose coupling; the notion of financial risk; long-term vs. short-term risk; coherent measures of risk.

Understand the conditions for sustainable funding: derivation of required returns; interplay between return levels, contribution levels and other parameters; influence of guaranteed benefits.

Understand the notion of risk-taking capability: capital process as a random walk; measures of long-term risk and relation to capital; short-term solvency vs. long-term stability; effect of embedded options and guarantees; interplay between required return and risk-taking capability.

Be able to study empirical properties of financial assets: the Normal hypothesis and the deviations from it; statistical tools for investigating relevant risk and return properties of financial assets; time aggregation properties; be able to conduct analysis of real data for the most important asset classes.

Understand and be able to carry out portfolio construction: the concept of diversification; limitations to diversification / correlation breakdown / what happened in 2008; the Kuhn-Tucker Theorem and optimization (mean-variance, mean-downside); incorporation of constraints; sensitivity and shortcomings of optimized portfolios.

Understand and interpret the asset-liability interplay: the optimized portfolio in the asset-liability framework; short-term risk vs. long-term risk; the influence of constraints; feasible and non-feasible solutions; practical considerations.

Know about active portfolio management: practical issues when implementing an investment strategy; the notion of active management; efficient markets hypothesis and limitations to it; empirical evidence; the fundamental law of active management; Bayesian concepts and the Black-Litterman framework.

Have an overall view: see the big picture of what asset returns can and cannot contribute to social security; be aware of the most relevant outcomes; know the role of the actuary in the financial risk management process.
### Content

For pension insurance and other forms of social insurance, investment returns are an important source of funding. In order to earn these returns, substantial financial risks must be taken, and these risks represent an important threat to financial stability, in the long term and in the short term.

Risk and return of financial assets cannot be separated from one another and, hence, asset management and risk management cannot be separated either. Managing financial risk in social and pension insurance is, therefore, the task of reconciling the contradictory dimensions of

1. Required return for a sustainable funding of the institution,
2. Risk-taking capability of the institution,
3. Returns available from financial assets in the market,
4. Risks incurred by investing in these assets.

This task must be accomplished under a number of constraints. Financial risk management in social insurance also means reconciling the long time horizon of the promised insurance benefits with the short time horizon of financial markets and financial risk.

It is not the goal of this lecture to provide the students with any cookbook recipes that can readily be applied without further reflection. The goal is rather to enable the students to develop their own understanding of the problems and possible solutions associated with the management of financial risks in social and pension insurance.

To this end, a rigorous intellectual framework will be developed and a powerful set of mathematical tools from the fields of actuarial mathematics and quantitative risk management will be applied. When analyzing the properties of financial assets, an empirical viewpoint will be taken using statistical tools and considering real-world data.

### Lecture notes

Since this is the first instance of this course, there is not yet a full script. However, to complement the blackboard notes, extensive handouts will be provided. Moreover, practical examples and data sets in Excel and Octave / Matlab will be made available to play around with and deepen the understanding of the subject matter.

### Prerequisites / notice

Solid base knowledge of probability and statistics is indispensable. Specialized concepts from financial and insurance mathematics as well as quantitative risk management will be introduced in the lecture as needed, but some prior knowledge in some of these areas would be an advantage.

This course counts towards the diploma of "Aktuar SAV".

The exams ONLY take place during the official ETH examination period.

#### Selection: Mathematical Physics, Theoretical Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0830-00L</td>
<td>General Relativity</td>
<td>W</td>
<td>10</td>
<td>4V+2U</td>
<td>P. Jetzer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Manifold, Riemannian metric, connection, curvature; Special Relativity; Lorentzian metric; Equivalence principle; Tidal force and spacetime curvature; Energy-momentum tensor, field equations, Newtonian limit; Post-Newtonian approximation; Schwarzschild solution; Mercury's perihelion precession, light deflection.</td>
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<tr>
<td>Objective</td>
<td>Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.</td>
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<tr>
<td>Literature</td>
<td>Suggested textbooks:</td>
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<tr>
<td></td>
<td>C. Misner, K. Thorne and J. Wheeler: Gravitation</td>
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<tr>
<td></td>
<td>S. Carroll - Spacetime and Geometry: An Introduction to General Relativity</td>
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<td></td>
<td>R. Wald - General Relativity</td>
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<td>S. Weinberg - Gravitation and Cosmology</td>
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<td></td>
<td>N. Straumann - General Relativity with applications to Astrophysics</td>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0822-13L</td>
<td>Introduction to Integrability</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>N. Beisert</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course gives an introduction to the theory of integrable systems, related symmetry algebras and efficient calculational methods.</td>
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<tr>
<td>Objective</td>
<td>Integrable systems are a special class of physical models that can be solved exactly due to an exceptionally large number of symmetries. Examples of integrable models appear in many different areas of physics, including classical mechanics, condensed matter, 2d quantum field theories and lately in string- and gauge theories. They offer a unique opportunity to gain a deeper understanding of generic phenomena in a simplified, exactly solvable setting. In this course we introduce the various notions of integrability in classical mechanics, quantum mechanics and quantum field theory. We discuss efficient methods for solving such models as well as the underlying enhanced symmetries.</td>
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<tr>
<td>Content</td>
<td>* Classical Integrability</td>
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<td></td>
<td>* Integrable Field Theory</td>
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<td></td>
<td>* Integrable Spin Chains</td>
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<tr>
<td></td>
<td>* Quantum Integrability</td>
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<td></td>
<td>* Integrable Statistical Mechanics</td>
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<td></td>
<td>* Quantum Algebra</td>
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<td></td>
<td>* Bethe Ansatz and Related Methods</td>
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<tr>
<td></td>
<td>* AdS/CFT Integrability</td>
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#### Selection: Mathematical Optimization, Discrete Mathematics

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<th>Number</th>
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<tbody>
<tr>
<td>401-3054-14L</td>
<td>Probabilistic Methods in Combinatorics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>B. Sudakov</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course provides a gentle introduction to the Probabilistic Method, with an emphasis on methodology. We will try to illustrate the main ideas by showing the application of probabilistic reasoning to various combinatorial problems.</td>
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<tr>
<td>Content</td>
<td>The topics covered in the class will include (but are not limited to): linearity of expectation, the second moment method, the local lemma, correlation inequalities, martingales, large deviation inequalities, Janson and Talagrand inequalities and pseudo-randomness.</td>
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</table>

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1117 of 1571
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will use these concepts in the computational and algorithmic setting. The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classic game-theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization.
- Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the 'Price of Anarchy').
- Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium.
- Selected current research topics, such as Google's Sponsored Search Auction, the U.S. FCC Spectrum Auction, Kidney Exchange.

Lecture notes
No lecture notes.

Literature
"Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

Prerequisites / notice
Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

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<tbody>
<tr>
<td>252-1407-00L</td>
<td>Algorithmic Game Theory</td>
<td>W</td>
<td>7 credits</td>
<td>3V+2U+1A</td>
<td>P. Widmayer, P. Penna</td>
</tr>
<tr>
<td>Abstract</td>
<td>Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.</td>
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<tr>
<td>Objective</td>
<td>Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.</td>
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<tr>
<td>Content</td>
<td>The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.</td>
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<tr>
<td>252-0417-00L</td>
<td>Randomized Algorithms and Probabilistic Methods</td>
<td>W</td>
<td>7 credits</td>
<td>3V+2U+1A</td>
<td>A. Steger, E. Welzl</td>
</tr>
<tr>
<td>Abstract</td>
<td>Las Vegas &amp; Monte Carlo algorithms: inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, SSAT, card shuffling, random walks</td>
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<tr>
<td>Objective</td>
<td>After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.</td>
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<tr>
<td>Content</td>
<td>Randomized Algorithms are algorithms that &quot;flip coins&quot; to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.</td>
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<tbody>
<tr>
<td>252-1425-00L</td>
<td>Geometry: Combinatorics and Algorithms</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U+1A</td>
<td>B. Gärtner, E. Welzl, M. Hoffmann, A. Pilz</td>
</tr>
<tr>
<td>Abstract</td>
<td>Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)</td>
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<tr>
<td>Objective</td>
<td>The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains. In particular, we want to prepare students for conducting independent research, for instance, within the scope of a thesis project.</td>
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<tr>
<td>Content</td>
<td>Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in Rd, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.</td>
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<tbody>
<tr>
<td>263-4655-00L</td>
<td>Lattice Cryptography</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>V. Lyubashevsky</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course will introduce lattice-based cryptography, which is one of the main candidates for quantum-resistant cryptography. The objective of the course is to bring the students up to a level where they should be able to read academic papers on state-of-the-art designs of lattice-based primitives.</td>
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Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1118 of 1571
In this course, we will study lattice-based cryptography. We will cover the basic algorithms associated with integer lattices such as Gram-Schmidt orthogonalization, algorithms for finding short and near lattice vectors, as well as the critical algorithm for sampling lattice points according to a discrete Gaussian distribution. We will then proceed to build up a toolbox of lattice-based cryptographic primitives beginning from collision-resistant hash functions, moving on to digital signatures, encryption, identity-based encryption, and fully-homomorphic encryption. Particular emphasis will be placed on concrete parameters and practical instantiations. For this purpose, we will also study cryptographic constructions based on the hardness of ideal lattices, which are ideals of polynomial rings.

Prerequisites / notice
There are no formal mathematical pre-requisites, but students should have "mathematical maturity", which entails dealing with abstract concepts and being comfortable with doing mathematical proofs. Some previous exposure to linear algebra, abstract algebra, and cryptography would be useful.

Selection: Further Realms

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<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3502-66L</td>
<td>Reading Course  ■</td>
<td>W</td>
<td>2 credits</td>
<td>4A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Please send an email to Studiensekretariat D-MATH <studiensekretariat@math.ethz.ch> including the following pieces of information:
1) which Reading Course (60, 90, 120 hours of work, corresponding to 2, 3, 4 ECTS credits) you wish to register;
2) in which semester;
3) for which degree programme;
4) your name and first name;
5) your student number;
6) the name and first name of the supervisor of the Reading Course.

Abstract
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3503-66L</td>
<td>Reading Course  ■</td>
<td>W</td>
<td>3 credits</td>
<td>6A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

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1) which Reading Course (60, 90, 120 hours of work, corresponding to 2, 3, 4 ECTS credits) you wish to register;
2) in which semester;
3) for which degree programme;
4) your name and first name;
5) your student number;
6) the name and first name of the supervisor of the Reading Course.

Abstract
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<tr>
<td>401-3504-66L</td>
<td>Reading Course  ■</td>
<td>W</td>
<td>4 credits</td>
<td>9A</td>
<td>Professors</td>
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</table>

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2) in which semester;
3) for which degree programme;
4) your name and first name;
5) your student number;
6) the name and first name of the supervisor of the Reading Course.

Abstract
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

Core Courses and Electives (Mathematics Master)

Core Courses (Mathematics Master)

Electives (Mathematics Master)

Seminars

Early enrolments for seminars in myStudies are encouraged, so that we will recognize need for additional seminars in a timely manner. Some seminars have waiting lists. Nevertheless, register for at most two mathematics seminars. In this case, you express a stronger preference for the seminar for which you register earlier.

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>401-3200-64L</td>
<td>Proofs from THE BOOK  ■</td>
<td>W</td>
<td>4 credits</td>
<td>2S</td>
<td>M. Burger</td>
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</tbody>
</table>
401-3570-66L  Algebraic Number Theory  W  4 credits  2S  J. Fresán
Number of participants limited to 12.

Abstract
Much of the progress in algebraic number theory aimed at solving concrete Diophantine equations. At the heart of the problem lies the fact that the ring of integers of a number field does not have unique factorization. The "class group" measures how much this property fails. The seminar will present basic results around this invariant, including finiteness and the relation to zeta functions.

Content
The following topics will be covered:
- The quadratic reciprocity law
- The geometry of numbers
- Integral quadratic forms
- Number fields and rings of integers
- Finiteness of the class number
- Unique factorization of ideals
- The Dedekind zeta function of a number field and the class number formula

Literature
Our basic reference will be chapters I and VII of Neukirch's book "Algebraic number theory" (Grundlehren Math. Wiss. 322. Springer-Verlag, Berlin, 1999). Additional references will be given at the beginning of the seminar.

Prerequisites / notice
Basic knowledge of algebraic structures (groups, rings, fields) and Galois theory, at the level of Algebra I and II. More advanced topics will be explained when needed.

401-3180-66L  Homological Algebra  W  4 credits  2S  C. Busch
Number of participants limited to 12.

Abstract
Basic concepts of homological algebra, homology and cohomology of groups.

Literature

Prerequisites / notice
Basic knowledge of algebraic structures (groups, rings, fields) and Galois theory, at the level of Algebra I and II. More advanced topics will be explained when needed.

401-3640-66L  Monte Carlo and Quasi-Monte Carlo Methods: Mathematical and Numerical Analysis  W  4 credits  2S  C. Schwab
Number of participants limited to 6.

Abstract
Introduction and current research topics in the theory and implementation of Monte Carlo and quasi-Monte Carlo methods and applications.

Prerequisites / notice
Prerequisites:
Completed courses in Mathematical Statistics
Numerical Analysis of Elliptic/ Parabolic PDEs, or Numerical Analysis of Hyperbolic PDEs, or Numerical Analysis of Stochastic ODEs, and FAI, Probability Theory I.

for Analyzing and Approximating Nonlinear PDEs
Number of participants limited to 6.

Abstract
The seminar covers measure theoretic tools used for the analysis and approximation of nonlinear hyperbolic partial differential equations. In particular, we will discuss Young measures, compensated compactness, weak-strong uniqueness and algorithms for the approximation of measure-valued solutions. The participants will present individual topics based on the study of research papers.

Objective
- To learn some measure theoretic tools for the analysis and approximation of nonlinear PDEs.

Content
- To read and understand a research paper and present it in an understandable way to other students.

Partial differential equations can be used to model an abundance of natural and physical phenomena, as well as industrial processes. Many of the more sophisticated and more realistic models involve nonlinear PDEs, among others, PDEs in fluid dynamics, astrophysics, elasticity or weather modeling. The solutions to these often exhibit complex structures, such as shocks, oscillations, singularities that are difficult to deal with mathematically and numerically. In our seminar we aim to get a better understanding of the difficulties that arise when dealing with nonlinear PDEs. In particular, we will discuss solutions problems related to the PDEs of fluid dynamics. Solutions to these equations may exhibit shocks and oscillations, and have less regularity than what the definition of a classical solution requires. Therefore, the solution concept has to be relaxed. One way of doing this, is to look for solutions in the space of measures instead of actual functions. Our goal in this seminar is to try to understand this concept better by studying research papers related to this issue. Specifically, we will discuss weak convergence in general, the notion of Young measures as a means to represent weak limits of nonlinear functions, and its application to compensated compactness, existence of solutions to scalar hyperbolic conservation laws, Euler equations, turbulence and statistical solutions of Navier-Stokes equations. We will also discuss algorithms to approximate solutions in the space of measures.

We are open to extend the list of topics by others that are of special interests to the attending students.

Literature
J. M. Ball. A version of the fundamental theorem for Young measures (1989).

Prerequisites / notice
Good knowledge of real functional analysis required, knowledge of hyperbolic partial differential equations and/or numerical analysis of advantage.
Abstract
The analysis of differential games with a large number of players finds applications in various research fields, from physics to economics and finance. The aim of Mean Field Games theory is to provide a suitable approximation of such problems with a higher tractability.

Objective
This course aims to give a broad understanding of the basic ideas of Mean Field Games, the main mathematical tools and the possible applications.

Content
We first present and analyze toy models of Mean Field Games in order to familiarize with the subject and to understand what kind of problems can be solved with this theory.

We explore two different approaches to Mean Field Games. From an analytic point of view it consists of a coupled system of PDEs. From a probabilistic point of view it amounts to a particular type of stochastic differential equations.

Literature
1) Notes on Mean Field Games. P. Cardaliaguet
2) Mean Field Games. J.M. Lasry, P.L. Lions
3) Probabilistic theory of Mean Field Games and applications. R. Carmona, F. Delarue

Prerequisites / notice
Basic knowledge of stochastic differential equations including Brownian Motion and stochastic differential equations.

GESS Science in Perspective
Science in Perspective
Autumn Semester 2016
Recommended Science in Perspective (Type B) for D-MATH.

see Science in Perspective: Type A: Enhancement of Reflection Capability

Language Courses

see Science in Perspective: Language Courses ETH/UZH

Additional Courses

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<tbody>
<tr>
<td>401-5000-00L</td>
<td>Zurich Colloquium in Mathematics</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>W. Werner, P. L. Bühlmann, M. Burger, S. Mishra, R. Pandharipande, University lecturers</td>
</tr>
<tr>
<td>401-5990-00L</td>
<td>Zurich Graduate Colloquium (University of Zurich)</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>University lecturers</td>
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</table>

Abstract

The Graduate Colloquium is an informal seminar aimed at graduate students and postdocs whose purpose is to provide a forum for communicating one's interests and thoughts in mathematics.

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<tbody>
<tr>
<td>401-5960-00L</td>
<td>Colloquium on Mathematics, Computer Science, and Education</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>N. Hungerbühler, M. Akveld, J. Hromkovic, H. Klemenz</td>
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</tbody>
</table>

Abstract

Subject didactics for mathematics and computer science teachers.

Didactics colloquium


Abstract

Research colloquium

Occasionally, talks may be delivered in German.


Abstract

Research colloquium

The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work for.

251-0100-00L | Computer Science Colloquium                                       | E-         | 0    | 2K    | Lecturers                                      |

Abstract

Invited talks, covering the entire scope of computer science. External Listeners are welcome at no charge. A detailed schedule is published at the beginning of each semester.

Objective

Top international computer scientists take the floor at the distinguished computer science colloquium. Our guest speakers present impacting topics across various areas of the discipline. The colloquium series is held every semester and also includes inaugural and farewell lectures of the department's professors. The colloquium is a noteworthy event for all graduate students. Outside attendance is equally welcome.

Content

Eingeladene Vorträge aus dem gesamten Bereich der Informatik, zu denen auch Auswärtige kostenlos eingeladen sind. Zu Semesterbeginn erscheint jeweils ein ausführliches Programm.

Mathematics Bachelor - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
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</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<td>Key for Hours</td>
<td>English counterpart</td>
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<td>lecture with exercise</td>
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<td>exercise</td>
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<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS  European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### Educational Science

General course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
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<td>This lecture is only apt for students who intend to enrol in the</td>
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<td>programs &quot;Teaching Diploma&quot; or &quot;Teaching Certificate&quot;. It is about</td>
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<td>learning in childhood and adolescent.</td>
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<tr>
<td>Abstract</td>
<td>This course looks into scientific theories and also empirical</td>
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<td></td>
<td>studies on human learning and relates them to the school.</td>
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<td>Objective</td>
<td>Anyone wishing to be a successful teacher must first of all understand</td>
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<td></td>
<td>the learning process. Against this background, theories and findings</td>
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<td>on the way humans process information and on human behaviour are</td>
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<td>prepared in such a manner that they can be used for planning and</td>
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<td>conducting lessons. Students additionally gain an understanding of</td>
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<td>what is going on in learning and behavioural research so that teachers</td>
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<td>are put in a position where they can further educate themselves in</td>
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<td></td>
<td>the field of research into teaching and learning.</td>
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<td>Content</td>
<td>Thematische Schwerpunkte: Lernen als Verhaltensänderung und als</td>
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<td></td>
<td>Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer</td>
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<td></td>
<td>Berücksichtigung der Verarbeitung symbolischer Information; Lernen</td>
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<td>als Wissenskonstruktion und Kompetenzentwicklung. Die Rolle von</td>
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<td></td>
<td>Emotion und Motivation beim Lernen; Interindividuelle Unterschiede</td>
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<td>in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien,</td>
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<td>Geschlechtsunterschiede beim Lernen.</td>
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<td></td>
<td>Lernformen: Theorien und wissenschaftliche Konstrukte werden zusammen</td>
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<td>mit ausgewählten wissenschaftlichen Untersuchungen in Form einer</td>
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<td></td>
<td>Vorlesung präsentiert. Die Studierenden vertiefen nach jeder Stunde</td>
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<td></td>
<td>die Inhalte durch die Bearbeitung von Aufträgen in einem elektronischen</td>
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<tr>
<td></td>
<td>Lerntagebuch. Über die Bedeutung des Gelernten für den Schulalltag</td>
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<td>soll reflektiert werden. Ausgewählte Tagebucherträge werden zu Beginn</td>
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<td>jeder Vorlesung thematisiert.</td>
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<td>Folien werden zur Verfügung gestellt.</td>
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<tr>
<td>Literature</td>
<td>1) Marcus Hasselhorn &amp; Andreas Goid (2006). Pädagogische Psychologie:</td>
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<td></td>
<td>Erfolgreiches Lernen und Lehren. Stuttgart: Kohlhammer. 2) Jeanne</td>
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<td>Hall.</td>
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<td>Prerequisites /</td>
<td>This lecture is only apt for students who intend to enrol in the</td>
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<tr>
<td>notice</td>
<td>programs &quot;Lehrdiplom&quot; or &quot;Didaktisches Zertifikat&quot;. It is about</td>
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<td>learning in childhood and adolescence.</td>
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<tr>
<th>Number</th>
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<tr>
<td>851-0240-03L</td>
<td>Introduction to Test Theory and Test Construction in Educational</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>University lecturers</td>
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<td>Contexts (University of Zürich)</td>
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<td>Enrolment only possible with Teaching Diploma or DC</td>
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<td>matriculation.</td>
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<td>No enrolment to this course at ETH Zurich. Book the corresponding</td>
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<td>module directly at UZH.</td>
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<td>UZH Module Code: 200a968</td>
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<td>Mind the enrolment deadlines at UZH:</td>
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<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<tr>
<td>Abstract</td>
<td>In this seminar, students are introduced to scientific fundamentals</td>
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<td>of performance measurement and educational diagnostics and study them</td>
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<td>on the basis of different current issues.</td>
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<td>Objective</td>
<td>At the end of the seminar, participants will be in a position to</td>
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<td>- describe the scientific fundamentals of test theory and test</td>
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<td>structure.</td>
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<td>- evaluate examples of scientifically-developed tests in their</td>
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<td>application context.</td>
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<td>- if necessary, critically question the performance assessment that</td>
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<td>they employ in practice and professionalise it still further.</td>
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<td>Content</td>
<td>Die konkreten Inhalte des Seminars ergeben sich aufgrund der</td>
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<td>Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht</td>
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<td>für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung</td>
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<td>wird eine Liste mit möglichen Themen abgegeben und erläutert.</td>
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<td></td>
<td>Schwerpunkte der Themenvorschläge sind:</td>
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<td>- Testentwicklung</td>
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<td>- Gütekriterien von Tests</td>
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<td>- Aufgabenkonstruktion</td>
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<td>- Datenauswertung</td>
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<td>- Rasch-Modell</td>
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<td>- Internationale Vergleichstests</td>
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<td>- Zulassungstests</td>
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<td>Lecture notes</td>
<td>Im Verlaufe des Semesters werden einzelne Unterragen in den</td>
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<td>Veranstaltungen abgegeben. Dazu gehören auch die Handouts der</td>
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<td>verschiedenen, studentischen Vorträge.</td>
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<td>Literature</td>
<td>Als Grundlagenliteratur werden folgende Werke empfohlen:</td>
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<tr>
<td></td>
<td>- Rost, J. (2004). Lehrbuch Testtheorie - Testkonstruktion (2. Aufl.),</td>
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<td>Bern: Huber</td>
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<td>Prerequisites /</td>
<td>Weitere Literatur wird in der Lehrveranstaltung genannt.</td>
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<td>notice</td>
<td>Die Leistungsanforderungen richten sich im Umfang nach der Zahl der</td>
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<td>erwerbbarer ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von</td>
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<td>ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen</td>
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<td>dieser Veranstaltung 3 ECTS-Punkte erwerben.</td>
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<td>Dazu sind folgende Leistungen zu erbringen:</td>
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<td></td>
<td>- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung</td>
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<td>- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung</td>
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<td>- Referat (RE)</td>
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<td>- Schreiben einer schriftlichen Arbeit</td>
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<tr>
<td>851-0240-15L</td>
<td>Colloquium on the Science of Learning and Instruction</td>
<td>W</td>
<td>1</td>
<td>1K</td>
<td>E. Stern, P. Greumann, further</td>
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<td></td>
<td>in the colloquium we discuss scientific projects concerning the</td>
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<td>teaching in mathematics, computer science, natural sciences and</td>
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<td>technology (STEM). The colloquium is conducted by the professorships</td>
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<td>participating in the Competence Center EducETH (ETH) and in the</td>
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<td>Institute for Educational Sciences (UZH).</td>
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<td>Abstract</td>
<td>In the colloquium we discuss scientific projects concerning the</td>
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<td>teaching in mathematics, computer science, natural sciences and</td>
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<td>Institute for Educational Sciences (UZH).</td>
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<tr>
<td>Objective</td>
<td>Participants are exemplarily introduced to different research methods</td>
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<td>used in research on learning and instruction and learn to weigh</td>
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<td></td>
<td>advantages and disadvantages of these approaches.</td>
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Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1124 of 1571
Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

On the basis of their understanding of mathematics, of the knowledge acquired from research into teaching/learning and subject teaching, students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

The seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Cognitively Activating Instructions in MINT Subjects

- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction
- Understanding findings relevant for education
- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

Subject Didactics and Professional Training

Important: You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.

Enrolment in either Mathematics Didactics I or Mathematics Didactics II (spring semester) is compulsory.

Number of participants limited to 20.

The successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

Prerequisites / notice

Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.
Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.

Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

They learn the skills of the teaching trade.

They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.

They learn to assess pupils' work.

- The objective is to familiarize themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.

- To show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content

The objective is for the students:

- To be able to familiarize themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.

- To show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

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<th>Type</th>
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<td>401-3057-00L</td>
<td>Finite Geometries II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
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<td></td>
<td>Objective</td>
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<td>Finite geometries I, II:</td>
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<td>Finite geometries combine</td>
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<td></td>
<td>aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.</td>
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<td>construct and analyse models</td>
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<td>of infinite geometries. They</td>
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<td>are familiar with closing</td>
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<td>theorems of the axioms of</td>
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<td>using the theory of finite</td>
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<td>construct orthogonal Latin</td>
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<td>elements of the theory of</td>
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<td>block design.</td>
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<td>- Max Jeger, Endliche</td>
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<td>Geometrien, ETH Skript 1988</td>
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<td>- Albrecht Beutelspacher:</td>
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<td>Einführung in die endliche</td>
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<td>Geometrie I,II, Bibliographisches Institut 1983</td>
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<td>- Margaret Lynn Batten:</td>
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<td>Combinatorics of Finite</td>
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<td>Geometries. Cambridge</td>
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<td>University Press</td>
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<td>- Dembowski: Finite</td>
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<td>The course Combinatorics I</td>
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<td>and II is an introduction</td>
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<td>enumerative combinatorics.</td>
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<td>Upon completion of the course</td>
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<td>classify combinatorial</td>
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<td>problems and to apply</td>
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<td>adequate techniques to solve</td>
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<td>401-0293-00L</td>
<td>Mathematics III</td>
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<td>3</td>
<td>2V+1U</td>
<td>A. Caspar, N. Hungerbühler</td>
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<td></td>
<td>Vertiefung der mehrdimensionalen Analysis with Schwerpunkt in der Anwendung der partiellen Differentialgleichungen, Vertiefung der Linearen Algebra und Einführung in die Systemanalyse und Modellbildung.</td>
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<td>Content</td>
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</tbody>
</table>
Objective

Die Studierenden

+ verstehen Mathematik als Sprache zur Modellbildung und als Werkzeug zur Lösung angewandter Probleme in den Naturwissenschaften.
+ können anspruchsvolle Modelle analysieren, Lösungen qualitativ beschreiben oder allenfalls explizit berechnen: diskret/kontinuierlich in Zeit, Ebene und Raum.
+ können Beispiele und konkrete arithmetische und geometrische Situationen der Anwendungen mit Methoden der höheren Mathematik interpretieren und bearbeiten.

Content

### Modellbildung ###
- Einführung und Beispiele
- Mehrdimensionale Modelle
- Pocken-Modell
- SIR-Modell

### Lineare Modelle ###
- Vektorräume
- Diagonalisierbarkeit
- Normalformen
- Exponential einer Matrix
- Lösungsraum eines Linearen DGL-Systems

### Fourier-Reihen ###
- Euklidische Vektorräume
- Orthogonale Projektion
- Anwendungen

### Nichtlineare Modelle ###
- Stationäre Lösungen, Qualitative Aussagen
- Mehrdimensionale Modelle: Räuber-Beute, Lotka-Volterra

### Partielle Differentialgleichungen ###
- Einführung, Repetition, Beispiele
- Fourier-Methoden: Wärmeleitung, Laplace, Wellengleichung, Filter, Computertomographie

### Laplace-Transformation ###
- Definition und Notation
- Rechenregeln
- Anwendungsbeispiel

Lecture notes


Literature


Prerequisites / notice

- Grundvorlesungen zur Analysis
- Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Mathematics for TC and Teaching Diploma.
Objective
The aim is for the students
- to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.
- to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership.
- To try out different options for specialist further training in their profession.

Content
Thematische Schwerpunkte:

Lernformen:

Lecture notes
Eine Anleitung zur mentorierten Arbeit in FV wird zur Verfügung gestellt.

Literature
Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Colloquia
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-5960-00L</td>
<td>Colloquium on Mathematics, Computer Science, and Education Subject didactics for mathematics and computer science teachers.</td>
<td>E-</td>
<td>0 credits</td>
<td></td>
<td>N. Hungerbühler, M. Akved, J. Hromkovic, H. Klemenz</td>
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</table>

Abstract
Didactics colloquium

Mathematics TC - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>Required</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Suitable for doctorate</td>
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</table>

Key for Hours

<table>
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<tr>
<th>Key for Hours</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
Mathematics Teaching Diploma

Detailed information on the programme at: www.didaktischeausbildung.ethz.ch

Mathematics as First Subject

Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Diploma Sport.</td>
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<tr>
<td>Abstract</td>
<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<tr>
<td>Objective</td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td></td>
<td>- Get information about recent literature on learning and instruction</td>
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<tr>
<td>Prerequisites</td>
<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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</table>

| 851-0242-07L  | Human Intelligence                                                     | W    | 1    | 1S    | E. Stern, P. Edelsbrunner, |
|               | Enrolment only possible with matriculation in Teaching Diploma or Teaching Diploma Sport. |
| Number of participants limited to 30. |
| Abstract      | The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed. |
| Objective     | - Understanding research methods used in the empirical human sciences |
|               | - Getting to know intelligence tests                                 |
|               | - Understanding findings relevant for education                      |

| 851-0242-08L  | Research Methods in Educational Science                               | W    | 1    | 1S    | P. Edelsbrunner, B. Rütsche, |
|               | Enrolment only possible with matriculation in Teaching Diploma or Teaching Diploma Sport. |
| Number of participants limited to 30. |
| Abstract      | Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work. |
| Objective     | - Understand research methods used in the empirical educational sciences |
|               | - Understand and critically examine information from scientific journals and media |
|               | - Understand pedagogically relevant findings from the empirical educational sciences |

| 851-0242-09L  | Student Research Projects: Practical Research on Learning and Instruction | W    | 2    | 2S    | A. Deiglmayr, P. Edelsbrunner, |
|               | Enrolment only possible with matriculation in Mathematics               |
| Number of participants limited to 20. |
| Abstract      | The successful completion of both course no. 851-0240-00L "Menschliches Lernen (EW 1)" and course no. 851-0239-01L "Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)" is a necessary prerequisite for this course. |
| Objective     | In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects. |
|               | The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning & Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction) |
| Learning goals include: |
| - Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples. |
| - Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction. |
| - Participants can design and conduct a study that is relevant for answering their research question. |
| - Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked. |
| see Educational Science Teaching Diploma |

Subject Didactics in Mathematics

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<tr>
<th>Number</th>
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<tr>
<td>401-3971-11L</td>
<td>Mathematics Didactics I</td>
<td>O</td>
<td>4</td>
<td>2G</td>
<td>K. Barro</td>
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</table>
Teaching Diploma or Mathematics TC at ETH or in Mathematics Teaching Diploma at UZH.

**Abstract**

Students learn about and learn to use findings from empirical research into mathematical didactics and best practice, as well as theoretical approaches to teaching various topics in mathematics. Methodological suggestions are compared and draft tuition concepts discussed.

**Objective**

On the basis of their understanding of mathematics, of the knowledge acquired from research into teaching/learning and subject teaching, and also of best practice, students who have completed this course will be in a position to draft motivating learning arrangements, with cognitive appeal, which trigger and maintain learning processes. The aim here is to implement a corresponding teaching plan, so that the mathematics tuition that is given has a general-education value, on the one hand, and ensures that pupils acquire the fundamental knowledge necessary for studying at university, on the other hand.

---

**Mentored Work Subject Didactics Mathematics A**

**Course Code:** 401-9983-00L

**ECTS:** 2 credits

**Credits:** 4A

**Lecturers:** M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler, A. F. Müller

**Objective**

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Content**

The objective is for the students:

- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Prerequisites / notice**

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

---

**Mentored Work Subject Didactics Mathematics B**

**Course Code:** 401-9984-00L

**ECTS:** 2 credits

**Credits:** 4A

**Lecturers:** M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler, A. F. Müller

**Objective**

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Content**

The objective is for the students:

- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Prerequisites / notice**

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

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**Professional Training in Mathematics**

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<td>Introductory Internship Mathematics</td>
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<td>3 credits</td>
<td>6P</td>
<td>N. Hungerbühler</td>
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</tbody>
</table>

During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.

**Objective**

Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

**Content**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credit</th>
<th>Prerequisites / Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3971-99L</td>
<td>Professional Exercises in Mathematics</td>
<td>O</td>
<td>1 credit</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Mathematics</td>
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<tr>
<td></td>
<td>Teaching Diploma or Mathematics TC at ETH.</td>
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<tr>
<td></td>
<td>Simultaneous enrolment in Mathematics Didactics - course unit 401-3971-11L - compulsory.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>Students learn about and learn to use findings from empirical research into mathematical didactics and best practice, as well as methodological suggestions are compared and draft tuition concepts discussed.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>On the basis of their understanding of mathematics, of the knowledge acquired from research into teaching/learning and subject teaching, and also of best practice, students who have completed this course will be in a position to draft motivating learning arrangements, with cognitive appeal, which trigger and maintain learning processes. The aim here is to implement a corresponding teaching plan, so that the mathematics tuition that is given has a general-education value, on the one hand, and ensures that pupils acquire the fundamental knowledge necessary for studying at university, on the other hand.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / Notice</td>
<td>This course is to be chosen jointly with 401-3972-00L.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / Notice</td>
<td>Findet in der Regel am Schluss der Ausbildung, vor Ablegung der Prüfungslektionen statt.</td>
<td></td>
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</tr>
<tr>
<td>401-3972-00L</td>
<td>Teaching Internship Mathematics for Teaching Diploma Mathematics as Major Subject</td>
<td>O</td>
<td>8 credits</td>
</tr>
<tr>
<td>Abstract</td>
<td>The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.</td>
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<tr>
<td></td>
<td>- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils.</td>
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<td></td>
<td>- They acquire the skills of the teaching trade.</td>
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<td></td>
<td>- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.</td>
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<tr>
<td></td>
<td>- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Fügt sich ein.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / Notice</td>
<td>This course is to be chosen jointly with 401-3972-00L.</td>
<td></td>
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</tr>
<tr>
<td>401-3979-00L</td>
<td>Teaching Internship Mathematics for students upgrading TC to Teaching Diploma.</td>
<td>W</td>
<td>4 credits</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is a supplement to the Teaching Internship required to obtain a Master of Advanced Studies in Secondary and Higher Education in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.</td>
<td></td>
<td></td>
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<tr>
<td>Objective</td>
<td>Die Studierenden können die Bedeutung von Unterrichtsthemen in ihrem Fach unter verschiedenen Blickwinkeln einschätzen. Sie kennen und beherrschen das unterrichtliche Handwerk. Sie können ein gegebenes Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adäquate Lernumgebung umsetzen. Es gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu finden, sodass die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, um aktiv und effektiv flexibel nutzbares (Fach-)Wissen zu erwerben.</td>
<td></td>
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<tr>
<td>Literature</td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
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</tr>
<tr>
<td>Prerequisites / Notice</td>
<td>Findet in der Regel am Schluss der Ausbildung, vor Ablegung der Prüfungslektionen statt.</td>
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<tr>
<td>401-3991-01L</td>
<td>Examination Lesson I Mathematics</td>
<td>O</td>
<td>1 credit</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.</td>
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<tr>
<td>Objective</td>
<td>On the basis of a specified topic, the candidate shows that they are in a position to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.</td>
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<tr>
<td></td>
<td>- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Dokument: Schriftliche Vorbereitung für Prüfungslektionen.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / Notice</td>
<td>Nach Abschluss der übrigen Ausbildung.</td>
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<tr>
<td>401-3991-02L</td>
<td>Examination Lesson II Mathematics</td>
<td>O</td>
<td>1 credit</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.</td>
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</tr>
<tr>
<td>Literature</td>
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<td></td>
<td></td>
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<tr>
<td>Prerequisites / Notice</td>
<td>Findet in der Regel am Schluss der Ausbildung, vor Ablegung der Prüfungslektionen statt.</td>
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</tr>
</tbody>
</table>
Objective
On the basis of a specified topic, the candidate shows that they are in a position
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Content

Lecture notes
Dokument: Schriftliche Vorbereitung für Prüfungslektionen.

Prerequisites / notice
Nach Abschluss der übrigen Ausbildung.


<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>401-3057-00L</td>
<td>Finite Geometries II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>401-0293-00L</td>
<td>Mathematics III</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>A. Caspar, N. Hungerbühler</td>
</tr>
</tbody>
</table>

Abstract
- Combinatorics II: The course Combinatorics I and II is an introduction into the field of enumerative combinatorics.
- Finite Geometries II: Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.

Objective
- Combinatorics II: Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.
- Finite Geometries II: Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design.
- Mathematics III: The students will understand Mathematics as a language for modeling and as a tool for solving real-world problems in the natural sciences. They can analyze complex models, describe solutions qualitatively or exclusively in the discrete/continuous in time, plane, and space.

Content
- Combinatorics I and II: congruence transformation of the plane, symmetry groups of geometric figures, Euler's function, Cayley graphs, formal power series, permutation groups, cycles, Bunsdse's lemma, cycle index, Polya's theorems, applications to graph theory and isomers.
- Finite Geometries I, II: finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler's thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Moebius planes, error correcting codes, block design.

Literature
- Max Jeger, Endliche Geometrien, ETH Skript 1988
- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II. Bibliographisches Institut 1983
- Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press
- Dembowski: Finite Geometries.
### Modellbildung ###
- Einführung und Beispiele
- Mehrdimensionale Modelle
- Pocken-Modell
- SIR-Modell

### Lineare Modelle ###
- Vektorräume
- Diagonalisierbarkeit
- Normalformen
- Exponential einer Matrix
- Lösungsraum eines Linearen DGL-Systems

### Fourier-Reihen ###
- Euklidische Vektorräume
- Orthogonale Projektion
- Anwendungen

### Nichtlineare Modelle ###
- Stationäre Lösungen, Qualitative Aussagen
- Mehrdimensionale Modelle: Räuber-Beute, Lotka-Volterra

### Partielle Differentialgleichungen ###
- Einführung, Repetition, Beispiele
- Fourier-Methoden: Wärmeleitung, Laplace, Wellengleichung, Filter, Computertomographie

### Laplace-Transformation ###
- Definition und Notation
- Rechenregeln
- Anwendungsbeispiel

---

#### Lecture notes ####

**II (nächstes Semester)**

Für Regelment (Prüfungsblock) Bachelor-Studiengang Maschineningenieurwissenschaften 2010; Ausgabe 15.01.2013 (Prüfungsblock)

#### Literature ####

Siehe Lernmaterial > Literaturl (nächstes Semester) Für Regelment (Prüfungsblock) Bachelor-Studiengang Maschineningenieurwissenschaften 2010; Ausgabe 15.01.2013 (Prüfungsblock)

#### Prerequisites / notice ####

Vorlesungen Mathematik I/II

---

**401-0293-99L** Mathematics III (Supplement)  
W 1 credit 1A A. Caspar, N. Hungerbühler

*Simultaneous enrolment in "Mathematics III" (401-0293-00L) is compulsory.*

#### Abstract ####


#### Objective ####

Die Studierenden kennen die wesentlichen Elemente der mathematischen Modellierung. Sie sind in der Lage, Modelle zu erstellen und mathematisch zu diskutieren. Sie können selbständig Unterrichtsssequenzen zur Modellierung entwickeln.

#### Content ####

- Modellbildung
- Lineare Modelle:
  - Vektorräume,
  - Normalformen,
  - Lösungsraum eines Linearen DGL-Systems
- Qualitative Aussagen, Nichtlineare Modelle:
  - Stabilität für eine DGL 1.Ordnung, für allgemeine DGL-Systeme
  - Modelle in Raum und Zeit:
    - Partielle DGL
    - Fourier-Reihe, - Transformation,
    - Laplace-Operator

#### Literature ####


#### Prerequisites / notice ####

Grundvorlesungen zur Analysis

---

**401-9985-00L** Mentored Work Specialised Courses in the Respective O Subject with an Educational Focus Mathematics A  

*Simultaneous enrolment in "Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Mathematics for TC and Teaching Diploma.*

#### Abstract ####

In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

#### Objective ####

The aim is for the students
- to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.
- to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership.
- To try out different options for specialist further training in their profession.
**Compulsory Elective Courses**

*Further course offerings from the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".*

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course Combinatorics I and II is an introduction into the field of enumerative combinatorics.</td>
<td></td>
<td></td>
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<td>Objective</td>
<td>Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.</td>
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<td>Content</td>
<td>Contents of the lectures Combinatorics I and II: congruence transformation of the plane, symmetry groups of geometric figures, Euler's function, Cayley graphs, formal power series, permutation groups, cycles, Bunsen's lemma, cycle index, Polya's theorems, applications to graph theory and isomers.</td>
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| Literature| - Max Jeger, Endliche Geometrien, ETH Skript 1988  
- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II, Bibliographisches Institut 1983  
- Margaret Lynn Batten: Combinatorics of Finite Geometries, Cambridge University Press  
- Dembowski: Finite Geometries. |

| 401-3057-00L | Finite Geometries II                             | W    | 4    | 2G    | N. Hungerbühler   |
| Abstract    | Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares. |
| Objective   | Finite geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design. |
| Content     | Finite geometries I, II: finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler's thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Mobius planes, error correcting codes, block design. |
| Literature  | - Dembowski: Finite Geometries. |

| 401-9951-58L | Didactics of Mathematics at the College Level I  
(University of Zurich) | W    | 3    | 2S    | R. Schelldorfer   |
| Abstract    | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 090MaDgU |
| Notice      | Enrolment only possible with matriculation in Teaching Diploma or TC at ETH or in Teaching Diploma at UZH. Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html |
| Objective   | Students are familiarised with the subjects taught at high-school level I (the first three years of the full-length high school, or the first year of the reduced-length high school). The central contents of geometry, arithmetic and algebra, and also written mathematical problems are explained. |
| Content     | In the teaching given at high-school level I (the first three years of the full-length high school or the first year of the reduced-length high school), central concepts and approaches adopted in mathematics are introduced and observed in greater depth. These include variables, function, proof. This calls for a careful didactic analysis on the part of the teacher, requiring them to study and reflect on the prerequisites for the pupils and the requirements in terms of mathematics and cognitive psychology. |
| Literature  | Vielfältige Aufgaben zum Einsatz im Unterricht werden vorgestellt, selber gelöst und diskutiert. |
| - Arithmetik und Algebra: Zahlbereiche, Form und Inhalt in der Algebra  
- Geometrie: Konstruieren-Berechnen-Beweisen, dynamische Geometrie (Geogebra).  
- Sachrechnen: Funktionsbegriff, mathematische Modellierung.  
- Aktuelle mathematikdidaktische Aspekte wie Lernprozesse, Grundvorstellungen, Kompetenzen, offene Aufgaben. |

| 252-0855-00L | Computer Science in Secondary School Mathematics | W    | 4    | 3G    | J. Hromkovic, G. Serafini |
| Notice       | Seminar mit Übungen |

Data: 06.11.2018 12:57   Autumn Semester 2016
The unit "Computer Science in Secondary School Mathematics" addresses key contributions of computer science to general education, the tight relations between the algorithmic and the mathematical way of thinking, and the thoughtful choice of computer science topics for high school mathematics classes.

The general goal of the course consists in presenting ways to teach fundamentals of computer science, which are closely related to contents and methods of mathematics. After attending the course unit, a mathematics teacher is able to teach selected fundamentals of computer science in mathematics classes.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

The main topics of the course unit "Computer Science in Secondary School Mathematics" represent a scientific and didactic added value for mathematics classes.

The course covers the didactics of logic, of cryptography, of finite state automata, of computability and of the introduction to programming. The students develop the understanding of fundamental scientific concepts such as algorithm, program, complexity, determinism, computation, automata, verification, testing, security of a cryptosystem and secure communication. They reflect on ways to embed them into a scientifically sound and didactically sustainable mathematics course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

In the course unit "Computer Science in Secondary School Mathematics" students gain an overview of the didactics methods and techniques that are introduced at the beginning of the semester. They develop and document an adaptive teaching unit for computer science. In an exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>401-3971-11L</td>
<td>Mathematics Didactics I</td>
<td>O</td>
<td>4</td>
<td>2G</td>
<td>K. Barro</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Mathematics Teaching Diploma or Mathematics TC at ETH or in Mathematics Teaching Diploma at UZH.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>Students learn about and learn to use findings from empirical research into mathematical didactics and best practice, as well as theoretical approaches to teaching various topics in mathematics. Methodological suggestions are compared and draft tuition concepts discussed.</td>
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<tr>
<td>Objective</td>
<td>On the basis of their understanding of mathematics, of the knowledge acquired from research into teaching/learning and subject teaching, and also of best practice, students who have completed this course will be in a position to draft motivating learning arrangements, with cognitive appeal, which trigger and maintain learning processes. The aim here is to implement a corresponding teaching plan, so that the mathematics tuition that is given has a general-education value, on the one hand, and ensures that pupils acquire the fundamental knowledge necessary for studying at university, on the other hand.</td>
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<tr>
<td>Content</td>
<td>In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.</td>
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<tr>
<td>Objective</td>
<td>The objective is for the students:</td>
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<tr>
<td>Content</td>
<td>Thematiche Schwerpunkte</td>
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<tr>
<td></td>
<td>Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.</td>
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<tr>
<td>Lecture notes</td>
<td>Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.</td>
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</tr>
</tbody>
</table>
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

### Mentored Work Subject Didactics Mathematics B

#### Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

#### Objective
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

#### Content
Themenatische Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

#### Lecture notes
Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

#### Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

### Professional Training in Mathematics

#### Number
401-9987-00L

#### Title
Teaching Internship Including Examination Lessons Mathematics

#### Type
O

#### ECTS
4 credits

#### Hours
9P

#### Lecturers
N. Hungerbühler

#### Abstract
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are are assessed as Examination Lessons.

#### Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

#### Content

#### Lecture notes
Dokument; schriftliche Vorbereitung für Prüfungslektionen.

#### Literature
Wird von der Praktikumslehrperson bestimmt.

### Colloquia

#### Number
401-5960-00L

#### Title
Colloquium on Mathematics, Computer Science, and Education

#### Type
E-

#### ECTS
0 credits

#### Lecturers
N. Hungerbühler, M. Akveld, J. Hromkovic, H. Klemenz

#### Abstract
Didactics colloquium

### Mathematics Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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Data: 06.11.2018 12:57
Autumn Semester 2016
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### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
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</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Mathematics Master

Core Courses

For the Master's degree in Applied Mathematics the following additional condition (not manifest in myStudies) must be obeyed: At least 15 of the required 28 credits from core courses and electives must be acquired in areas of applied mathematics and further application-oriented fields.

Core Courses: Pure Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3225-00L</td>
<td>Introduction to Lie Groups</td>
<td>W</td>
<td>8 credits</td>
<td>4G</td>
<td>P. D. Nelson</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Topological groups and Haar measure. Definition of Lie groups, examples of local fields and examples of discrete subgroups; basic properties; Lie subgroups. Lie algebras and relation with Lie groups: exponential map, adjoint representation. Semisimplicity, nilpotency, solvability, compactness: Killing form, Lie's and Engel's theorems. Definition of algebraic groups and relation with Lie groups.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>The goal is to have a broad though foundational knowledge of the theory of Lie groups and their associated Lie algebras with an emphasis on the algebraic and topological aspects of it.</td>
</tr>
<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
<td></td>
<td>A. Knapp: &quot;Lie groups beyond an Introduction&quot; (Birkhaeuser)</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>H. Samelson: &quot;Notes on Lie algebras&quot; (Springer, '90)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S. Helgason: &quot;Differential geometry, Lie groups and symmetric spaces&quot; (Academic Press, '78)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F. Warner: &quot;Foundations of differentiable manifolds and Lie groups&quot; (Springer)</td>
</tr>
</tbody>
</table>

Core Courses: Applied Mathematics and Further Appl.-Oriented Fields

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3510-00L</td>
<td>Numerical Methods for Elliptic and Parabolic Partial Differential Equations</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>C. Schwab</td>
</tr>
<tr>
<td></td>
<td>Course audience at ETH: 3rd year ETH BSc Mathematics and MSc Mathematics and MSc Applied Mathematics students. Other ETH-students are advised to attend the course &quot;Numerical Methods for Partial Differential Equations&quot; (401-0674-00L) in the CSE curriculum during the spring semester.</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>This course gives a comprehensive introduction into the numerical treatment of linear and non-linear elliptic boundary value problems, related eigenvalue problems and linear, parabolic evolution problems. Emphasis is on theory and the foundations of numerical methods.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Participants of the course should become familiar with concepts underlying the discretization of elliptic and parabolic boundary value problems, analytical techniques for investigating the convergence of numerical methods for the approximate solution of boundary value problems, methods for the efficient solution of discrete boundary value problems, implementational aspects of the finite element method.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>A selection of the following topics will be covered: Elliptic boundary value problems, Galerkin discretization of linear variational problems, the primal finite element method, Mixed finite element methods, Discontinuous Galerkin Methods, Boundary element methods, Spectral methods, Adaptive finite element schemes, Singularly perturbed problems, Sparse grids, Galerkin discretization of elliptic eigenproblems, Non-linear elliptic boundary value problems, Discretization of parabolic initial boundary value problems.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>Course slides will be made available to the audience.</td>
</tr>
<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
<td></td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>Practical exercises based on MATLAB</td>
</tr>
<tr>
<td>401-3520-00L</td>
<td>Fundamentals of Mathematical Statistics</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>F. Balabdaoui</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>The course covers the basics of inferential statistics.</td>
</tr>
<tr>
<td>401-4889-00L</td>
<td>Mathematical Finance</td>
<td>W</td>
<td>11 credits</td>
<td>4V+2U</td>
<td>M. Schweizer</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Advanced level introduction to mathematical finance, presupposing knowledge in probability theory and stochastic processes.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>This is an advanced level introduction to mathematical finance for students with a good background in probability. We want to give an overview of main concepts, questions and approaches, and we do this in both discrete- and continuous-time models. Topics include absence of arbitrage and martingale measures, option pricing and hedging, optimal investment problems, and probably others. Prerequisites are probability theory and stochastic processes (for which lecture notes are available).</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Advanced level introduction to mathematical finance: absence of arbitrage and martingale measures, option pricing and hedging, optimal investment problems, additional topics.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>None available</td>
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<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
<td></td>
<td>Details will be announced in the course.</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>Prerequisites are probability theory and stochastic processes (for which lecture notes are available).</td>
</tr>
</tbody>
</table>
Mathematical Optimization

W
11 credits
4V+2U
R. Weismantel

Abstract
Mathematical treatment of diverse optimization techniques.
Advanced optimization theory and algorithms.

Objective
1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas' Lemma and infeasibility certificates, duality theory of linear programming.
3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.
4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

★☆ (also Bachelor) Core Courses: Pure Mathematics

Further restrictions apply, but in particular:
401-3531-00L Differential Geometry I can only be recognised for the Master Programme if 401-3532-00L Differential Geometry II has not been recognised for the Bachelor Programme.

Analogously for:
401-3461-00L Functional Analysis I - 401-3462-00L Functional Analysis II
401-3001-61L Algebraic Topology I - 401-3002-12L Algebraic Topology II
401-3132-00L Commutative Algebra - 401-3146-12L Algebraic Geometry
401-3371-00L Dynamical Systems I - 401-3372-00L Dynamical Systems II

For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

Number Title Type ECTS Hours Lecturers
401-3461-00L Functional Analysis I W 10 credits 4V+1U M. Struwe

Abstract
Baire category; Banach and Hilbert spaces, bounded linear operators; three fundamental principles: Uniform boundedness, open mapping/closed graph theorem, Hahn-Banach; convexity; dual spaces; weak and weak* topologies; Banach-Alaoglu; reflexive spaces; compact operators and Fredholm theory; closed range theorem; spectral theory of self-adjoint operators in Hilbert spaces.

Lecture notes
Lecture Notes on "Funktionalanalysis I" by Michael Struwe

401-3531-00L Differential Geometry I W 10 credits 4V+1U U. Lang

Abstract
Curves in R^n, inner geometry of hypersurfaces in R^n, curvature, Theorema Egregium, special classes of surfaces, Theorem of Gauss-Bonnet. Hyperbolic space. Differentiable manifolds, tangent bundle, immersions and embeddings, Sard's Theorem, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.

Objective
Introduction to elementary differential geometry and differential topology.

Content
- Differential geometry in R^n: theory of curves, submanifolds and immersions, inner geometry of hypersurfaces, Gauss map and curvature, Theorema Egregium, special classes of surfaces, Theorem of Gauss-Bonnet, Poincaré Index Theorem.
- The hyperbolic space.
- Differential topology: differentiable manifolds, tangent bundle, immersions and embeddings in R^n, Sard's Theorem, transversality, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.

Literature
Differential Geometry in R^n:
- Manfredo P. do Carmo: Differential geometry of curves and surfaces
- Wolfgang Kühnel: Differentialgeometrie. Curves-surfaces-manifolds
- Christian Bär: Elementary differential geometry
Differential Topology:
- Dennis Barden & Charles Thomas: An Introduction to Differential Manifolds
- Victor Guillemin & Alan Pollack: Differential Topology
- Morris W. Hirsch: Differential Topology

401-3371-00L Dynamical Systems I W 10 credits 4V+1U W. Merry

Abstract
This course is a broad introduction to dynamical systems. Topic covered include topological dynamics, ergodic theory and low-dimensional dynamics.

Objective
Mastery of the basic methods and principal themes of some aspects of dynamical systems.
Topics covered include:

1. Topological dynamics
   (transitivity, attractors, chaos, structural stability)

2. Ergodic theory
   (Poincare recurrence theorem, Birkhoff ergodic theorem, existence of invariant measures)

3. Low-dimensional dynamics
   (Poincare rotation number, dynamical systems on $[0,1]$)

The most relevant textbook for this course is Introduction to Dynamical Systems, Brin and Stuck, CUP, 2002.

I will also produce full lecture notes.

Prerequisites / notice

The material of the basic courses of the first two years of the program at ETH is assumed. In particular, you should be familiar with metric spaces and elementary measure theory.

401-3001-61L

Algebraic Topology I  

Abstract

This is an introductory course in algebraic topology. The course will cover the following main topics: introduction to homotopy theory, homology and cohomology of spaces.

Literature


Book can be downloaded for free at:
http://www.math.cornell.edu/%7ehatcher/AT/ATpage.html

See also:
http://www.math.cornell.edu/%7ehatcher/#anchor1772800

3) E. Spanier, "Algebraic topology", Springer-Verlag

General topology, linear algebra.

Some knowledge of differential geometry and differential topology is useful but not absolutely necessary.

401-3132-00L

Commutative Algebra

Abstract

This course provides an introduction to commutative algebra as a foundation for and first steps towards algebraic geometry. The material in this course will be assumed in the lecture course "Algebraic Geometry" in the spring semester 2017.

Objective

We shall cover approximately the material from
--- most of the textbook by Atiyah-MacDonald, or
--- the first half of the textbook by Bosch.

Topics include:
* Basics about rings, ideals and modules
* Localization
* Primary decomposition
* Integral dependence and valuations
* Noetherian rings
* Completions
* Basic dimension theory

Literature

Primary Reference:

Secondary Reference:
2. "Algebraic Geometry and Commutative Algebra" by S. Bosch (Springer 2013)

Tertiary References:

Prerequisites / notice

Prerequisites: Algebra I (or a similar introduction to the basic concepts of ring theory).

(Also Bachelor) Core Courses: Applied Mathematics ...

Further restrictions apply, but in particular:

401-3601-00L Probability Theory can only be recognised for the Master Programme if neither 401-3642-00L Brownian Motion and Stochastic Calculus nor 401-3602-00L Applied Stochastic Processes has been recognised for the Bachelor Programme.

402-0205-00L Quantum Mechanics I is eligible as an applied core course, but only if 402-0224-00L Theoretical Physics (offered for the last time in FS 2016) isn't recognised for credits (neither in the Bachelor's nor in the Master's programme).

For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

Number  Title                Type  ECTS  Hours  Lecturers

401-3601-00L Probability Theory

This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from none of the three course units 401-3601-00L Probability Theory, 401-3642-00L Brownian Motion and Stochastic Calculus resp. 401-3602-00L Applied Stochastic Processes for their Bachelor's degree still can have recognised this course for the Master's degree.

Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.
Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.

Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), probability theory, stochastic processes, discrete time.

This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are presented:

2. Introduction to the Circle Method.
3. Quantum Mechanics I.
4. Group and Representation Theory: Beyond an MMP course.
5. Topics in Rigidity Theory.
6. Reading Course: Abelian Varieties over Finite Fields.

### Electives: Pure Mathematics

For the Master's degree in Applied Mathematics the following additional condition (not manifest in myStudies) must be obeyed: At least 15 of the required 28 credits from core courses and electives must be acquired in areas of applied mathematics and further application-oriented fields.

### Electives: Selection of Mathematics, Logic, and Discrete Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-3117-66L</td>
<td>Introduction to the Circle Method</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>E. Kowalski</td>
</tr>
<tr>
<td>401-4209-66L</td>
<td>Group and Representation Theory: Beyond an Introduction</td>
<td>W</td>
<td>8 credits</td>
<td>3V+1U</td>
<td>T. H. Willwacher</td>
</tr>
<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td>W</td>
<td>4 credits</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>401-4145-66L</td>
<td>Reading Course: Abelian Varieties over Finite Fields</td>
<td>W</td>
<td>2 credits</td>
<td>4A</td>
<td>J. Fresán, P. S. Jossen</td>
</tr>
</tbody>
</table>

### Literature

- H. Bauer, Probability Theory, de Gruyter 1996
- J. Jacob and P. Protter, Probability essentials, Springer 2004
- D. Williams, Probability with martingales, Cambridge University Press 1991
- H. Iwaniec and E. Kowalski, "Analytic number theory", chapter 20; AMS
- C. Cohen-Tannoudji: Quantum mechanics

### Lectures

- E. Kowalski: Probability Theory
- N. Hungerbühler: Group and Representation Theory
- J. Fresán: Reading Course: Abelian Varieties over Finite Fields
- M. Burger: Topics in Rigidity Theory

### Literature

- F. Schwab: Quantum mechanics
- J.J. Sakurai: Modern Quantum Mechanics
- H. Bauer, Probability Theory, de Gruyter 1996
- D. Williams, Probability with martingales, Cambridge University Press 1991
- H. Iwaniec and E. Kowalski, "Analytic number theory", chapter 20; AMS
- C. Cohen-Tannoudji: Quantum mechanics I

### Objective

- This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:
  - Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.
- This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:
  - Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.
- Despite the title, the course will begin by a recollection of basic concepts of group and representation theory, in particular that of finite groups and Lie groups.
- Contents of the lectures Combinatorics I and II: congruence transformation of the plane, symmetry groups of geometric figures, Euler's function, Cayley graphs, formal power series, permutation groups, cycles, Bunsdie's lemma, cycle index, Polya's theorems, applications to graph theory and isomers.
- The goal of the course is to study several classical and important (and beautiful!) topics in group and representation theory, that are otherwise often overlooked in a standard curriculum.
- The lecture will present an introduction to this method. In particular, it will present the solution of Waring's Problem concerning the representability of integers as sums of a bounded numbers of (fixed) powers of integers.
- The circle method, invented by Hardy and Ramanujan and developped by Hardy and Littlewood and Kloosterman, is one of the most versatile methods currently available to determine the asymptotic behavior of the number of integral solutions to polynomial equations, when the number of solutions is sufficiently large.
- The lecture will present an introduction to this method. In particular, it will present the solution of Waring's Problem concerning the representability of integers as sums of a bounded numbers of (fixed) powers of integers.
- The course of the course is to give detailed proofs of Margulis' normal subgroup theorem and his superrigidity theorem for lattices in higher rank Lie groups.
- This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:
  - Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.
- The circle method, invented by Hardy and Ramanujan and developped by Hardy and Littlewood and Kloosterman, is one of the most versatile methods currently available to determine the asymptotic behavior of the number of integral solutions to polynomial equations, when the number of solutions is sufficiently large.
- The lecture will present an introduction to this method. In particular, it will present the solution of Waring's Problem concerning the representability of integers as sums of a bounded numbers of (fixed) powers of integers.
- The course of the course is to give detailed proofs of Margulis' normal subgroup theorem and his superrigidity theorem for lattices in higher rank Lie groups.
- This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:
  - Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.
- This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:
  - Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.
Content

This course gives an introduction to rigidity theory, which is a set of techniques initially invented to understand the structure of a certain class of discrete subgroups of Lie groups, called lattices, and currently used in more general contexts of groups arising as isometries of non-positively curved geometries. A prominent example of a lattice in the Lie group $\text{SL}(n, \mathbb{R})$ is the group $\text{SL}(n, \mathbb{Z})$ of integer $n \times n$ matrices with determinant 1. Prominent questions concerning this group are:

- Describe all its proper quotients.
- Classify all its finite dimensional linear representations.
- More generally, can this group act by diffeomorphisms on "small" manifolds like the circle?
- Does its Cayley graph considered as a metric space at large scale contain enough information to recover the group structure?

In this course we will give detailed treatment for the answers to the first two questions; they are respectively Margulis' normal subgroup theorem and Margulis' superrigidity theorem. These results, valid for all lattices in simple Lie groups of rank at least 2--like $\text{SL}(n, \mathbb{R})$, with $n$ at least 3--lead to the arithmeticity theorem, which says that all lattices are obtained by an arithmetic construction.

Literature

- D. Witte-Morris: "Introduction to Arithmetic groups", available on Arxiv
- Y. Benoist: "Five lectures on lattices in semisimple Lie groups", available on his homepage.
- M.Burger: "Rigidity and Arithmeticity", European School of Group Theory, 1996, handwritten notes, will be put online.

Prerequisites / notice

For this course some knowledge of elementary Lie theory would be good. We will however treat Lie groups by examples and avoid structure theory since this is not the point of the course nor of the techniques.

401-3309-66L

Riemann Surfaces (Part 2)

W 4 credits 2V A. Buryak

Abstract

The program will be the following:

- Proof of the Serre duality;
- Riemann-Hurwitz formula;
- Functions and differential forms on a compact Riemann surface with prescribed principal parts;
- Weierstrass points on a compact Riemann surface;
- The Jacobian and the Picard group of a compact Riemann surface;
- Holomorphic vector bundles;
- Non-compact Riemann surfaces.

Literature

O. Forster. Lectures on Riemann Surfaces.

Prerequisites / notice

This is a continuation of 401-3308-16L Riemann Surfaces that was taught in the spring semester (FS 2016), see https://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnxhbGV4YW5kcmJ1cnkrh3ZvWVVybWVwYVldIg4QJoqQOM11M

401-3597-00L

Finite Geometries II

W 4 credits 2G N. Hungerbühler

Objective

Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.

Content

Finite geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design.

Literature

- Max Jeger, Endliche Geometrien, ETH Skript 1988
- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II. Bibliographisches Institut 1983
- Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press
- Dembowski: Finite Geometries.

Selection: Analysis

Number Title Type ECTS Hours Lecturers

401-3556-11L

Geometric Aspects of Hamiltonian Dynamics

W 6 credits 3V P. Biran

Abstract

The course will concentrate on the geometry of the group of Hamiltonian diffeomorphisms introduced by Hofer in the early 1990's and its relations to various topics in symplectic geometry such as capacities, Lagrangian submanifolds, holomorphic curves, as well as recent algebraic structures on the group of Hamiltonian diffeomorphisms such as quasi-morphisms.

Literature

Books:
- L. Polterovich: "The geometry of the group of symplectic diffeomorphisms"
- H. Hofer & E. Zehnder: "Symplectic invariants and Hamiltonian dynamics"

Prerequisites / notice

Prerequisites. Good knowledge of undergraduate mathematics (analysis, complex functions, topology, and differential geometry). Some knowledge of elementary algebraic topology would be useful.

401-4767-66L

Partial Differential Equations (Hyperbolic PDEs)

W 7 credits 4V D. Christodouloou

Abstract

The course begins with characteristics, the definition of hyperbolicity, causal structure and the domain of dependence theorem. The course then focuses on nonlinear systems of equations in two independent variables, in particular the Euler equations of compressible fluids with plane symmetry and the Einstein equations of general relativity with spherical symmetry.

Objective

The objective is to introduce students in mathematics and physics to an area of mathematical analysis involving differential geometry which is of fundamental importance for the development of classical macroscopic continuum physics.

Content

The course shall begin with the basic structure associated to hyperbolic partial differential equations, characteristic hypersurfaces and bicharacteristics, causal structure, and the domain of dependence theorem. The course shall then focus on nonlinear systems of equations in two independent variables. The first topic shall be the Euler equations of compressible fluids under plane symmetry where we shall study the formation of shocks, and second topic shall be the Einstein equations of general relativity under spherical symmetry where we shall study the formation of black holes and spacetime singularities.

Prerequisites / notice

Basic real analysis and differential geometry.
Mathematical Themes in General Relativity

Objectives:
- First part of a one-year course offering a rigorous introduction to general relativity, with special emphasis on aspects of current interest in mathematical research. Topics covered include: initial value formulation of the Einstein equations, causality theory and singularities, constructions of data sets by gluing or conformal methods, asymptotically flat spaces and positive mass theorems.

Content:
- Lorentzian geometry; geometric review of special relativity; the Einstein equations and their basic classes of special solutions; the Einstein equations as an initial-value problem; causality theory and hyperbolicity; singularities and trapped domains; Penrose diagrams; asymptotically flat spaces: ADM invariants, positive mass theorems, Penrose inequalities, geometric properties.

Lecture Notes:
- Lecture notes written by the instructor will be provided to all enrolled students.

Prerequisites / Notice:
- The content of the basic courses of the first three years at ETH will be assumed. In particular, enrolled students are expected to be fluent both in Differential Geometry (at least at the level of Differential Geometrie I, II) and Functional Analysis (at least at the level of Funktionalanalysis I, II). Some background on partial differential equations, mainly of elliptic and hyperbolic type, (say at the level of the monograph by L. C. Evans) would also be desirable.

ECTS Credits:
- 4 ECTS credits
- 6 ECTS credits
- 4 ECTS credits
- 6 ECTS credits
- 4 ECTS credits
- 6 ECTS credits
- 4 ECTS credits
- 6 ECTS credits

Registration:
- Enrolled students may register for the Reading Course by sending an email to Studiensekretariat D-MATH including the following pieces of information:
  1) which Reading Course (60, 90, 120 hours of work, corresponding to 2, 3, 4 ECTS credits) you wish to register;
  2) the time you are available to attend lectures; and
  3) your current academic year.

For more details, please follow the link in the Learning materials section.
2) in which semester;
3) for which degree programme;
4) your name and first name;
5) your student number;
6) the name and first name of the supervisor of the Reading Course.

Abstract
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

<table>
<thead>
<tr>
<th>Reading Course</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3503-66L</td>
<td>W</td>
<td>3</td>
<td>6A</td>
<td>Professors</td>
</tr>
<tr>
<td>401-3504-66L</td>
<td>W</td>
<td>4</td>
<td>9A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Electives: Applied Mathematics and Further Application-Oriented Fields

Selection: Numerical Analysis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-4657-00L</td>
<td>Numerical Analysis of Stochastic Ordinary Differential Equations</td>
<td>W</td>
<td>6</td>
<td>3V+1U</td>
<td>A. Jentzen</td>
</tr>
</tbody>
</table>

Abstract
Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

Objective
The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Content
- Generation of random numbers
- Monte Carlo methods for the numerical integration of random variables
- Stochastic processes and Brownian motion
- Stochastic ordinary differential equations (SODEs)
- Numerical approximations of SODEs
- Multilevel Monte Carlo methods for SODEs
- Applications to computational finance: Option valuation

Lecture notes
Lecture Notes are available in the lecture homepage (please follow the link in the Learning materials section).

Literature
P. Glassermann:
Monte Carlo Methods in Financial Engineering.

P. E. Kloeden and E. Platen:
Numerical Solution of Stochastic Differential Equations.
Start of lectures: Wednesday, September 21, 2016
For more details, please follow the link in the Learning materials section.

**401-4785-00L Mathematical and Computational Methods in Photonics**

Objectives:
- The field of photonics encompasses the fundamental science of light propagation and interactions in complex structures, and its technological applications.
- The recent advances in nanoscience present great challenges for the applied and computational mathematics community. In nanophotonics, the aim is to control, manipulate, reshape, and focus electromagnetic waves at nanometer length scales, beyond the resolution limit. In particular, one wants to break the resolution limit by reducing the focal spot and confine light to length scales that are significantly smaller than half the wavelength.
- Interactions between the field of photonics and mathematics has led to the emergence of a multitude of new and unique solutions in which today's conventional technologies are approaching their limits in terms of speed, capacity and accuracy. Light can be used for detection and measurement in a fast, sensitive and accurate manner, and thus photonics possesses a unique potential to revolutionize healthcare. Light-based technologies can be used effectively for the very early detection of diseases, with non-invasive imaging techniques or point-of-care applications. They are also instrumental in the analysis of processes at the molecular level, giving a greater understanding of the origin of diseases, and hence allowing prevention along with new treatments. Photonic technologies also play a major role in addressing the needs of our ageing society: from pace-makers to synthetic bones, and from endoscopes to the micro-cameras used in in-vivo processes. Furthermore, photonics are also used in advanced lighting technology, and in improving energy efficiency and quality. By using photonic media to control waves across a wide band of wavelengths, we have an unprecedented ability to fabricate new materials with specific microstructures.
- The main objective in this course is to report on the use of sophisticated mathematics in diffractive optics, plasmonics, super-resolution, photonic crystals, and metamaterials for electromagnetic invisibility and cloaking. The course merges highly nontrivial multi-mathematics in order to make a breakthrough in the field of mathematical modelling, imaging, and optimal design of optical nanodevices and nanostructures capable of light enhancement, and of the focusing and guiding of light at a subwavelength scale. We demonstrate the power of layer potential techniques in solving challenging problems in photonics, when they are combined with asymptotic analysis and the elegant theory of Gohberg and Sigal on meromorphic operator-valued functions.
- In this course we shall consider both analytical and computational matters in photonics. The issues we consider lead to the investigation of fundamental problems in various branches of mathematics. These include asymptotic analysis, spectral analysis, mathematical imaging, optimal design, stochastic modelling, and analysis of wave propagation phenomena. On the other hand, deriving mathematical foundations, and new and efficient computational frameworks and tools in photonics, requires a deep understanding of the different scales in the wave propagation problem, an accurate mathematical modelling of the nanodevices, and fine analysis of complex wave propagation phenomena. An emphasis is put on mathematically analyzing plasmon resonant nanoparticles, diffractive optics, photonic crystals, super-resolution, and metamaterials.

#### Selection: Probability Theory, Statistics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-4604-66L</td>
<td>Topics in Probability Theory</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>W. Werner</td>
</tr>
<tr>
<td>401-3604-66L</td>
<td>Special Topics in Probability: Recent Developments in Percolation Theory</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>P. Nolin</td>
</tr>
</tbody>
</table>

### Literature
- B. Bollobas, O. Riordan: Percolation, CUP 2006

### Prerequisites
- 401-2604-00L Probability and Statistics (mandatory)
- 401-3601-00L Probability Theory (recommended)
Prerequisites / notice

**401-3627-00L**  
**High-Dimensional Statistics**  

<table>
<thead>
<tr>
<th>W</th>
<th>4 credits</th>
<th>2V</th>
<th>P. L. Bühlmann</th>
</tr>
</thead>
</table>

**Abstract**

“High-Dimensional Statistics” deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.

**Objective**

Knowledge of methods and basic theory for high-dimensional statistical inference

**Content**

Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling

**Literature**


**Prerequisites / notice**

Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

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**401-4623-00L**  
**Time Series Analysis**  

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>3G</th>
<th>N. Meinshausen</th>
</tr>
</thead>
</table>

**Abstract**

Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

**Objective**

Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

**Content**

This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

**Literature**

Not available

**Prerequisites / notice**

Basic knowledge in probability and statistics

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**401-3612-00L**  
**Stochastic Simulation**  

<table>
<thead>
<tr>
<th>W</th>
<th>5 credits</th>
<th>3G</th>
<th>F. Sigrist</th>
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</thead>
</table>

**Abstract**

This course provides an introduction to statistical Monte Carlo methods. This includes applications of simulations in various fields (Bayesian statistics, statistical mechanics, operations research, financial mathematics), algorithms for the generation of random variables (accept-reject, importance sampling), estimating the precision, variance reduction, introduction to Markov chain Monte Carlo.

**Objective**

Stochastic simulation (also called Monte Carlo method) is the experimental analysis of a stochastic model by implementing it on a computer. Probabilities and expected values can be approximated by averaging simulated values, and the central limit theorem gives an estimate of the error of this approximation. The course shows examples of the many applications of stochastic simulation and explains different algorithms used for simulation. These algorithms are illustrated with the statistical software R.

**Content**


**Literature**

A script will be available in English. 


**Prerequisites / notice**

Familiarity with basic concepts of probability theory (random variables, joint and conditional distributions, laws of large numbers and central limit theorem) will be assumed.

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**401-3611-00L**  
**Advanced Topics in Computational Statistics**  

<table>
<thead>
<tr>
<th>W</th>
<th>4 credits</th>
<th>2V</th>
<th>M. H. Maathuis</th>
</tr>
</thead>
</table>

**Abstract**

This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.

**Objective**

Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

**Content**

The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

**Prerequisites / notice**

We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

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**401-0649-00L**  
**Applied Statistical Regression**  

<table>
<thead>
<tr>
<th>W</th>
<th>5 credits</th>
<th>2V+1U</th>
<th>M. Dettling</th>
</tr>
</thead>
</table>

**Abstract**

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student’s own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

**Objective**

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

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**401-3613-00L**  
**Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling**

**Prerequisites / notice**

Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).
The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

A script will be available.

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

### Selection: Financial and Insurance Mathematics

In the Master's programmes in Mathematics resp. Applied Mathematics 401-3913-01L Mathematical Foundations for Finance is eligible as an elective course, but Oehlert & Wüthrich (1998): Introduction to Mathematical Finance isn't recognised for credits (neither in the Bachelor's nor in the Master's programme). For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

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<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>401-3925-00L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W</td>
<td>5 credits</td>
<td>2V+1U</td>
</tr>
<tr>
<td>Objective</td>
<td>Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.</td>
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</table>

### Non-Life Insurance: Mathematics and Statistics

The lecture aims at providing a basis in non-life insurance mathematics which forms a core subject of actuarial sciences. It discusses collective risk modeling, individual claim size modeling, approximations for compound distributions, ruin theory, premium calculation principles, tariffication with generalized linear models, credibility theory, claims reserving and solvency.

The student is familiar with the basics in non-life insurance mathematics and statistics. This includes the basic mathematical models for insurance liability modeling, pricing concepts, stochastic claims reserving models and ruin and solvency considerations.

The following topics are treated:
- Collective Risk Modeling
- Individual Claim Size Modeling
- Approximations for Compound Distributions
- Ruin Theory in Discrete Time
- Premium Calculation Principles
- Tariffication and Generalized Linear Models
- Bayesian Models and Credibility Theory
- Claims Reserving
- Solvency Considerations

Lecture notes
M. V. Wüthrich, Non-Life Insurance: Mathematics & Statistics
http://ssrn.com/abstract=2319328

Prerequisites / notice
This course will be held in English and counts towards the diploma of "Aktuar SAV". For the latter, see details under www.actuaries.ch.

Prerequisites: knowledge of probability theory, statistics and applied stochastic processes.

### Life Insurance Mathematics

The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and endowment insurance and disability). Besides that the most important terms such as mathematical reserves are introduced and calculated.

The profit and loss account and the balance sheet of a life insurance company is explained and illustrated.

401-3922-00L | Life Insurance Mathematics | W | 4 credits | 2V |
| Abstract     | The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and endowment insurance and disability). Besides that the most important terms such as mathematical reserves are introduced and calculated. | | | |

### Financial Risk Management in Social and Pension Insurance

Investment returns are an important source of funding for social and pension insurance, and financial risk is an important threat to stability. We study short-term and long-term financial risk and its interplay with other risk factors, and we develop methods for the measurement and management of financial risk and return in an asset/liability context with the goal of ensuring sustainable funding.

401-3929-00L | Financial Risk Management in Social and Pension Insurance | W | 4 credits | 2V |
| Abstract     | Investment returns are an important source of funding for social and pension insurance, and financial risk is an important threat to stability. We study short-term and long-term financial risk and its interplay with other risk factors, and we develop methods for the measurement and management of financial risk and return in an asset/liability context with the goal of ensuring sustainable funding. | | | |
The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum mechanics. This lecture gives an introduction in the basic concepts and applications of statistical physics for the general use in physics and, in particular, as a preparation for the theoretical solid state physics education.

Objective
- Understand the basic asset-liability framework: essential principles and properties of social and pension insurance; cash flow matching, duration matching, valuation portfolio and loose coupling; the notion of financial risk; long-term vs. short-term risk; coherent measures of risk.
- Understand the conditions for sustainable funding: derivation of required returns; interplay between return levels, contribution levels and other parameters; influence of guaranteed benefits.
- Understand the notion of risk-taking capability: capital process as a random walk; measures of long-term risk and relation to capital; short-term solvency vs. long-term stability; effect of embedded options and guarantees; interplay between required return and risk-taking capability.
- Be able to study empirical properties of financial assets: the Normal hypothesis and the deviations from it; statistical tools for investigating relevant risk and return properties of financial assets; time aggregation properties; be able to conduct analysis of real data for the most important asset classes.
- Understand and be able to carry out portfolio construction: the concept of diversification; limitations to diversification / correlation breakdown / what happened in 2008; the Kuhn-Tucker Theorem and optimization (mean-variance, mean-downside); incorporation of constraints; sensitivity and shortcomings of optimized portfolios.
- Understand and interpret the asset-liability interplay: the optimized portfolio in the asset-liability framework; short-term risk vs. long-term risk; the influence of constraints; feasible and non-feasible solutions; practical considerations.
- Know about active portfolio management: practical issues when implementing an investment strategy; the notion of active management; efficient markets hypothesis and limitations to it; empirical evidence; the fundamental law of active management; Bayesian concepts and the Black-Litterman framework.
- Have an overall view: see the big picture of what asset returns can and cannot contribute to social security; be aware of the most relevant outcomes; know the role of the actuary in the financial risk management process.
- Risk and return of financial assets cannot be separated from one another and, hence, asset management and risk management cannot be separated either. Managing financial risk in social and pension insurance is, therefore, the task of reconciling the contradictory dimensions of
  1. Required return for a sustainable funding of the institution,
  2. Risk-taking capability of the institution,
  3. Returns available from financial assets in the market,
  4. Risks incurred by investing in these assets.
- It is not the goal of this lecture to provide the students with any cookbook recipes that can readily be applied without further reflection. The goal is rather to enable the students to develop their own understanding of the problems and possible solutions associated with the management of financial risks in social and pension insurance.
- To this end, a rigorous intellectual framework will be developed and a powerful set of mathematical tools from the fields of actuarial mathematics and quantitative risk management will be applied. When analyzing the properties of financial assets, an empirical viewpoint will be taken using statistical tools and considering real-world data.
- This task must be accomplished under a number of constraints. Financial risk management in social insurance also means reconciling the long time horizon of the promised insurance benefits with the short time horizon of financial markets and financial risk.
- Risk and return of financial assets cannot be separated from one another and, hence, asset management and risk management cannot be separated either. Managing financial risk in social and pension insurance is, therefore, the task of reconciling the contradictory dimensions of

Content
- For pension insurance and other forms of social insurance, investment returns are an important source of funding. In order to earn these returns, substantial financial risks must be taken, and these risks represent an important threat to financial stability, in the long term and in the short term.

Lecture notes
- Since this is the first instance of this course, there is not yet a full script. However, to complement the blackboard notes, extensive handouts will be provided. Moreover, practical examples and data sets in Excel and Octave / Matlab will be made available to play around with and deepen the understanding of the subject matter.

Prerequisites / notice
- Solid base knowledge of probability and statistics is indispensable. Specialized concepts from financial and insurance mathematics as well as quantitative risk management will be introduced in the lecture as needed, but some prior knowledge in some of these areas would be an advantage.

This course counts towards the diploma of “Aktuar SAV”.

The exams ONLY take place during the official ETH examination period.

401-4947-66L elective course <title tba> W 4 credits 2V P. Cheridito

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturer</th>
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</thead>
<tbody>
<tr>
<td>402-0843-00L</td>
<td>Quantum Field Theory I</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>C. Anastasiou</td>
</tr>
</tbody>
</table>

This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and special relativity.
- Topics include:
  - Relativistic quantum mechanics
  - Quantisation of bosonic and fermionic fields
  - Interactions in perturbation theory
  - Scattering processes and decays
  - Radiative corrections
- The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.

402-0861-00L | Statistical Physics | W | 10 credits | 4V+2U | G. Blatter |

This lecture covers the concepts of classical and quantum statistical physics, and some aspects of kinetic gas theory and hydrodynamics.
- In a more advanced part degenerate Fermions, Bose-Einstein condensation, real Bose gases, magnetism, general mean field theory and critical phenomena will be addressed.

This lecture gives an introduction in the basic concepts and applications of statistical physics for the general use in physics and, in particular, as a preparation for the theoretical solid state physics education.
Content
Basics of phenomenological thermodynamics, three laws of thermodynamics.
Hydrodynamics.
Classical statistical physics: microcanonical ensembles, canonical ensembles and grandcanonical ensembles, applications to simple systems.
Quantum statistical physics: single particle, ideal quantum gases, fermions and bosons.
Degenerate fermions: Fermi gas, electrons in magnetic field.
Bosons: Bose-Einstein condensation, Bogoliubov theory, superfluidity.
Critical phenomena: mean field, series expansions, scaling behavior, universality.
Renormalization group: fixed points, simple models.
Lecture notes
No specific book is used for the course. Relevant literature will be given in the course.

Literature
No specific book is used for the course. Relevant literature will be given in the course.

402-0830-00L General Relativity
W 10 credits 4V+2U P. Jetzer
Abstract
Manifold, Riemannian metric, connection, curvature; Special Relativity; Lorentzian metric; Equivalence principle; Tidal force and spacetime curvature; Energy-momentum tensor, field equations, Newtonian limit; Post-Newtonian approximation; Schwarzchild solution; Mercury's perihelion precession, light deflection.
Objective
Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.

402-0822-13L Introduction to Integrability
W 6 credits 2V+1U N. Beisert
Abstract
This course gives an introduction to the theory of integrable systems, related symmetry algebras and efficient calculational methods.
Objective
Integrable systems are a special class of physical models that can be solved exactly due to an exceptionally large number of symmetries. Examples of integrable models appear in many different areas of physics, including classical mechanics, condensed matter, 2d quantum field theories and latterly in string- and gauge theories. They offer a unique opportunity to gain a deeper understanding of generic phenomena in a simplified, exactly solvable setting. In this course we introduce the various notions of integrability in classical mechanics, quantum mechanics and quantum field theory. We discuss efficient methods for solving such models as well as the underlying enhanced symmetries.
Content
- Classical Integrability
- Integrable Field Theory
- Integrable Spin Chains
- Quantum Integrability
- Integrable Statistical Mechanics
- Quantum Algebra
- Bethe Ansatz and Related Methods
- AdS/CFT Integrability

401-3054-14L Probabilistic Methods in Combinatorics
W 6 credits 2V+1U B. Sudakov
Abstract
This course provides a gentle introduction to the Probabilistic Method, with an emphasis on methodology. We will try to illustrate the main ideas by showing the application of probabilistic reasoning to various combinatorial problems.
Content
The topics covered in the class will include (but are not limited to): linearity of expectation, the second moment method, the local lemma, correlation inequalities, martingales, large deviation inequalities, Janson and Talagrand inequalities and pseudo-randomness.

402-1425-00L Geometry: Combinatorics and Algorithms
W 6 credits 2V+2U+1A B. Gärtner, E. Welzl
Abstract
Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)
Objective
The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains.
Content
Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in Rd, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.

Selection: Mathematical Optimization, Discrete Mathematics

Autumn Semester 2016

Selection: Mathematical Optimization, Discrete Mathematics

Invalid data: 06.11.2018 12:57
Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.

The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classic game-theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization.
- Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the ‘Price of Anarchy’).
- Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium.
- Selected current research topics, such as Google's Sponsored Search Auction, the U.S. FCC Spectrum Auction, kidney exchange.

Prerequisites:
- No lecture notes.
- "Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

Lecture notes:
- Several copies of both books are available in the Computer Science library.

Audience:
- Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements:
- You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

Prerequisites:
- No prerequisites.

Outline:
- Introduction to classic game-theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization.
- Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the ‘Price of Anarchy’).
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Requirements:
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2) in which semester;
3) for which degree programme;
4) your name and first name;
5) your student number;
6) the name and first name of the supervisor of the Reading Course.

Abstract
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

401-3503-66L  Reading Course  W  3 credits  6A  Professors
THE ENROLMENT IS DONE BY THE STUDY ADMINISTRATION.

Please send an email to Studiensekretariat D-MATH <studiensekretariat@math.ethz.ch> including the following pieces of information:
1) which Reading Course (60, 90, 120 hours of work, corresponding to 2, 3, 4 ECTS credits) you wish to register;
2) in which semester;
3) for which degree programme;
4) your name and first name;
5) your student number;
6) the name and first name of the supervisor of the Reading Course.

Abstract
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

401-3504-66L  Reading Course  W  4 credits  9A  Professors
THE ENROLMENT IS DONE BY THE STUDY ADMINISTRATION.

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Abstract
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▶ Application Area
Only necessary and eligible for the Master degree in Applied Mathematics.
One of the application areas specified must be selected for the category Application Area for the Master degree in Applied Mathematics. At least 8 credits are required in the chosen application area.

►► Atmospheric Physics

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
</tbody>
</table>

Abstract
Dynamic, synoptic Meteorology

Objective
Understanding the dynamics of large-scale atmospheric flow

Content
Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes
Dynamics of large-scale atmospheric flow

Literature
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Prerequisites / notice
Physics I, II, Environmental Fluid Dynamics

►► Biology

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>551-0015-00L</td>
<td>Biology I</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>R. Glockshuber, E. Hafen</td>
</tr>
</tbody>
</table>

Abstract
The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject.

Objective
The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.
Content

Die folgenden Kapitelnummern beziehen sich auf das der Vorlesung zugrundeliegende Lehrbuch "Biology" (Campbell & Rees, 10th edition, 2015)
Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt

1. Aufbau der Zelle
Kapitel 5: Struktur und Funktion biologischer Makromoleküle
Kapitel 6: Eine Tour durch die Zelle
Kapitel 7: Membranstruktur und-funktion
Kapitel 8: Einführung in den Stoffwechsel
Kapitel 9: Zelluläre Atmung und Speicherung chemischer Energie
Kapitel 10: Photosynthese
Kapitel 12: Der Zellzyklus
Kapitel 17: Vom Gen zum Protein

2. Allgemeine Genetik
Kapitel 13: Meiose und Reproduktionszyklen
Kapitel 14: Mendelsche Genetik
Kapitel 15: Die chromosomale Basis der Vererbung
Kapitel 16: Die molekulare Grundlage der Vererbung
Kapitel 18: Genetik von Bakterien und Viren
Kapitel 46: Tierische Reproduktion

Lecture notes

Grundlagen des Stoffwechsels und eines Überblicks über molekulare Genetik

Literature

Der Vorlesungsstoff ist sehr nahe am Lehrbuch gehalten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.

Das folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:


Prerequisites / notice


636-0017-00L Computational Biology W 4 credits 3G T. Stadler, C. Magnus

Abstract

The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.

Objective

Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:

- stochastic models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics

Attendees will apply these concepts to a number of applications yielding biological insight into:

- epidemiology
- pathogen evolution
- macroevolution of species

Content

The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

Lecture notes

Slides of the lecture will be available online.

https://www.bsse.ethz.ch/cevo/education/cb-materials.html

Literature

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

Prerequisites / notice

Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

Computational Electromagnetics

Number Title Type ECTS Hours Lecturers
227-2037-00L Physical Modelling and Simulation W 5 credits 4G C. Hafner, J. Leuthold, J. Smajic

Abstract

This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics, and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

Objective

Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.

Content

The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, linear equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetic-thermal analysis of MEMS.

In the second part of the course the students will work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.
## Control and Automation

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>151-0563-01L</td>
<td>Dynamic Programming and Optimal Control</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>R. D’Andrea</td>
</tr>
</tbody>
</table>

### Abstract
- Introduction to Dynamic Programming and Optimal Control.
- Covers the fundamental concepts of Dynamic Programming & Optimal Control.

### Content
- Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

### Literature

### Prerequisites / notice
- Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

## Economics

### 363-0537-00L Resource and Environmental Economics

<table>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>363-0537-00L</td>
<td>Resource and Environmental Economics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. Bretschger, A. Brausmann</td>
</tr>
</tbody>
</table>

### Objective
- Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

### Topics
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments

### Content
- Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

### Literature

### Lecture notes
- Learning material and script can be found here: [https://moodle-app2.let.ethz.ch/course/view.php?id=328](https://moodle-app2.let.ethz.ch/course/view.php?id=328)

### 363-0503-00L Principles of Microeconomics

<table>
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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>363-0503-00L</td>
<td>Principles of Microeconomics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Filipinni</td>
</tr>
</tbody>
</table>

### Objective
- The course introduces basic principles, problems and approaches of microeconomics.

### Content
1. Students must be able to discuss basic principles, problems and approaches in microeconomics.
2. Students can analyse and explain simple economic principles in a market using supply and demand graphs.
3. Students can contrast different market structures and describe firm and consumer behavior.
4. Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole.
5. Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.

### Literature
- The book can also be used for the course Principles of Macroeconomics (Sturm)

### Lecture notes
- Lecture notes, exercises and reference material can be downloaded from Moodle.

### Literature

### Complementary
This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?

This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to everyday economic problems.

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2467) contains announcements, course information and lecture slides.


We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

The main aim of this course is to analyse the goals of monetary policy and to review the instruments available to central banks in order to pursue these goals. It will focus on the transmission mechanisms of monetary policy and the differences between monetary policy rules and discretionary policy. It will also make connections between theoretical economic concepts and current real world issues.

This lecture will introduce the fundamentals of monetary economics and explain the working and impact of monetary policy.

The course will be based on chapters of:

Basic knowledge in international economics and a good background in macroeconomics. The course website can be found at: https://moodle-app2.let.ethz.ch/course/view.php?id=2457

The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2457) contains announcements, course information and lecture slides.


We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.
Content

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media - Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing


Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow: unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:

Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Content

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### Image Processing and Computer Vision

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<th>Lecturers</th>
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<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W</td>
<td>6 credits</td>
<td>3V+1U</td>
<td>L. Van Gool, O. Göksel, E. Konukoglu</td>
</tr>
</tbody>
</table>

**Abstract**

**Objective**
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

**Content**
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

**Lecture notes**
Course material Script, computer demonstrations, exercises and problem solutions

**Prerequisites / notice**
Prerequisites: Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

### Information and Communication Technology

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<tr>
<td>227-0427-00L</td>
<td>Signal and Information Processing: Modeling, Filtering, Learning</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
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</tbody>
</table>

**Abstract**
Fundamentals in signal processing, detection/estimation, and machine learning.
I. Linear signal representation and approximation: Hilbert spaces, LMMSE estimation, regularization and sparsity.

**Objective**
The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

**Content**

**Lecture notes**
Lecture notes.

**Prerequisites / notice**
Prerequisites:
- local bachelors: course "Discrete-Time and Statistical Signal Processing" (5. Sem.)
- others: solid basics in linear algebra and probability theory

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0101-00L</td>
<td>Discrete-Time and Statistical Signal Processing</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>H.A. Loeliger</td>
</tr>
</tbody>
</table>
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.

The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are linearity and probability. In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm. A recurrent theme throughout the course is the stable and robust "inversion" of a linear filter.

1. Discrete-time linear systems and filters:
   - state-space realizations, z-transform and spectrum, decimation and interpolation, digital filter design, stable realizations and robust inversion.
2. The discrete Fourier transform and its use for digital filtering.
3. The statistical perspective:
   - probability, random variables, discrete-time stochastic processes; detection and estimation: MAP, ML, Bayesian MMSE, LMMSE; Wiener filter, LMS adaptive filter, Viterbi algorithm.

Lecture notes

Lecture Notes.

227-0417-00L Information Theory I W 6 credits 4G A. Lapidoth
Abstract
This course covers the basic concepts of information theory and of communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.

Objective
The fundamentals of Information Theory including Shannon's source coding and channel coding theorems

Content
The entropy rate of a source, Typical sequences, the asymptotic equi-partition property, the source coding theorem, Huffman coding, Arithmetic coding, channel capacity, the channel coding theorem, the source-channel separation theorem, feedback capacity

Literature
T.M. Cover and J. Thomas, Elements of Information Theory (second edition)

Material Modelling and Simulation

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-1201-00L</td>
<td>Transport Phenomena I</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>H. C. Öttinger</td>
</tr>
</tbody>
</table>

Abstract
Phenomenological approach to "Transport Phenomena" based on balance equations supplemented by thermodynamic considerations to formulate the undetermined fluxes in the local species mass, momentum, and energy balance equations; fundamentals, applications, and simulations

Objective
The teaching goals of this course are on five different levels:
1. Deep understanding of fundamentals: local balance equations, constitutive equations for fluxes, entropy balance, interfaces, idea of dimensionless numbers, ...
2. Ability to use the fundamental concepts in applications
3. Insight into the role of boundary conditions
4. Knowledge of a number of applications
5. Flavor of numerical techniques: finite elements, finite differences, lattice Boltzmann, Brownian dynamics, ...

Content
Approach to Transport Phenomena
   - Diffusion Equation
   - Brownian Dynamics
   - Refreshing Topics in Equilibrium Thermodynamics
   - Balance Equations
   - Forces and Fluxes
   - Measuring Transport Coefficients
   - Pressure-Driven Flows
   - Driven Separations
   - Complex Fluids

Lecture notes
A detailed manuscript is provided; this manuscript will be developed into a book entitled "A Modern Course in Transport Phenomena" by David C. Venerus and Hans Christian Öttinger

Literature
   - Equilibrium thermodynamics (Gibbs' fundamental equation; thermodynamic potentials; Legendre transforms). Maxwell equations.
   - Programming and simulation techniques (Matlab, Monte Carlo simulations).

Quantum Chemistry

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0003-00L</td>
<td>Advanced Quantum Chemistry</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>M. Reiher, S. Knecht</td>
</tr>
</tbody>
</table>

Abstract
Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems with a computer.

Examples are:
- Operators derived from principles of relativistic quantum mechanics
- Relativistic effects + methods of relativistic quantum chemistry
- Open-shell molecules + spin-density functional theory
- New electron-correlation theories
Objective

The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that this is necessary in order to be able to solve actual chemical problems on a computer with quantum chemical methods.

The relativistic re-derivation of all concepts known from (nonrelativistic) quantum mechanics and quantum chemistry lectures will finally explain the form of all operators in the molecular Hamiltonian - usually postulated rather than deduced. From this, we derive operators needed for molecular spectroscopy (like those required by magnetic resonance spectroscopy). Implications of other assumptions in standard non-relativistic quantum chemistry shall be analyzed and understood, too. Examples are the Born-Oppenheimer approximation and the expansion of the electronic wave function in a set of pre-defined many-electron basis functions (Slater determinants). Overcoming these concepts, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics. Also revisiting the workhorse of quantum chemistry, namely density functional theory, with an emphasis on open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor. It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

Content

1) Introductory lecture: basics of quantum mechanics and quantum chemistry
2) Einstein's special theory of relativity and the (classical) electromagnetic interaction of two charged particles
3) Klein-Gordon and Dirac equation; the Dirac hydrogen atom
4) Numerical methods based on the Dirac-Fock-Coulomb Hamiltonian, two-component and scalar relativistic Hamiltonians
5) Response theory and molecular properties, derivation of property operators, Breit-Pauli-Hamiltonian
6) Relativistic effects in chemistry and the emergence of spin
7) Spin in density functional theory
8) New electron-correlation theories: Tensor network and matrix product states, the density matrix renormalization group
9) Quantum chemistry without the Born-Oppenheimer approximation.

Lecture notes

A set of detailed lecture notes will be provided, which will cover the whole course.

Literature

2) F. Schwabl: Quantenmechanik für Fortgeschrittene (QM II), Springer-Verlag, 1997
3) R. McWeeny: Methods of Molecular Quantum Mechanics, Academic Press, 1992
8) Note also the standard textbooks:
   A) A. Szabo, N.S. Ostlund, Verlag, Dover Publications
   B) I. N. Levine, Quantum Chemistry, Pearson

Prerequisites / notice

Strongly recommended (preparatory) courses are: quantum mechanics and quantum chemistry

Simulating of Semiconductor Devices

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0157-00L</td>
<td>Semiconductor Devices: Physical Bases and</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Schenk</td>
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</tbody>
</table>

Abstract

The course addresses the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation. Necessary basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.

Objective

The course aims at the understanding of the principle physics of modern semiconductor devices, of the foundations in the physical modeling of transport and its numerical simulation. During the course also basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided.

Content

The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model, hydrodynamic model), physical characterization of silicon (intrinsic properties, scattering processes), mobility of cold and hot carriers, recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions. The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.

Lecture notes


Literature

The script (in book style) is sufficient. Further reading will be recommended in the lecture.

Systems Design

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<tr>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>F. Schweitzer, G. Casiraghi, V. Narumyan</td>
</tr>
</tbody>
</table>

Abstract

Finding solutions: what is complexity, problem solving cycle.

Implementing solutions: project management, critical path method, quality control feedback loop.

Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption

Objective

A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- set up and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics
This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and Statistical Physics. Lecture notes are available in German.

H. J. Herrmann

The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore, it prepares students for the advanced course in quantum field theory (Quantum Field Theory II) and research projects in theoretical physics, particle-physics, and condensed-matter physics.

G. Blatter

This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and supercomputers: classical equations of motion, partial differential equations, wave equation, diffusion equation, Maxwell's equation, Monte Carlo simulations, percolation, phase transitions.

C. Anastasiou

The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling. The course is structured along three main tasks:

1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models, analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

4V+2U

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM. The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

Prerequisites / notice

Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

Theoretical Physics

In the Master's programme in Applied Mathematics 402-0205-00L Quantum Mechanics I is eligible as a course unit in the application area Theoretical Physics. However, only 402-0205-00L Theoretical Physics wasn't or isn't recognised for credits (neither in the Bachelor's nor in the Master's program). For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
402-0809-00L | Introduction to Computational Physics | W | 8 credits | 2V+2U | H. J. Herrmann

Content

This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and supercomputers: classical equations of motion, partial differential equations, wave equation, diffusion equation, Maxwell's equation, Monte Carlo simulations, percolation, phase transitions.

Prerequisites / notice

Lecture notes are available in German. Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM. The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

Classical Mechanics

402-2203-01L | Classical Mechanics | W | 7 credits | 4V+2U | G. M. Graf

Abstract

A conceptual introduction to theoretical physics: Newtonian mechanics, central force problem, oscillations, Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.

Statistical Physics

402-0861-00L | Statistical Physics | W | 10 credits | 4V+2U | G. Blatter

Abstract

This lecture covers the concepts of classical and quantum statistical physics, and some aspects of kinetic gas theory and hydrodynamics. In a more advanced part degenerate Fermions, Bose-Einstein condensation, real Bose gases, magnetism, general mean field theory and critical phenomena will be addressed.

Prerequisites / notice

Lecture notes are available in English.

Quantum Field Theory I

402-0843-00L | Quantum Field Theory I | W | 10 credits | 4V+2U | C. Anastasiou

Abstract

This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and special relativity. Topics include:

- Relativistic quantum mechanics
- Quantisation of bosonic and fermionic fields
- Interactions in perturbation theory
- Scattering processes and decays
- Radiative corrections

Objective

The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore, it prepares students for the advanced course in quantum field theory (Quantum Field Theory II) and for research projects in theoretical physics, particle physics, and condensed-matter physics.

General Relativity

402-0830-00L | General Relativity | W | 10 credits | 4V+2U | P. Jetzer

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
Abstract
Manifold, Riemannian metric, connection, curvature; Special Relativity; Lorentzian metric; Equivalence principle; Tidal force and spacetime curvature; Energy-momentum tensor, field equations, Newtonian limit; Post-Newtonian approximation; Schwarzschild solution; Mercury's perihelion precession, light deflection.

Objective
Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.

Literature
Suggested textbooks:
C. Misner, K, Thorne and J. Wheeler: Gravitation
S. Carroll - Spacetime and Geometry: An Introduction to General Relativity
R. Wald - General Relativity
S. Weinberg - Gravitation and Cosmology
N. Straumann - General Relativity with applications to Astrophysics

Electives Theoretical Physics

Transportation Science

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0417-00L</td>
<td>Transport Planning Methods</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>K. W. Axhausen</td>
</tr>
</tbody>
</table>

Abstract
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems.

Objective
- Knowledge of methods and algorithms commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning

Content
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such planning problems are the estimation of traffic volumes, prediction of estimated utilization of new public transport lines, and evaluation of effects (e.g. change in emissions of a city) triggered by building new infrastructure and changes to operational regulations.

To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

Lecture notes
The slides of the lecture are provided electronically.

Literature

Seminars and Semester Papers

Seminars
Early enrolments for seminars in myStudies are encouraged, so that we will recognize need for additional seminars in a timely manner. Some seminars have waiting lists. Nevertheless, register for at most two mathematics seminars. In this case, you express a stronger preference for the seminar for which you register earlier.

<table>
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<tr>
<th>Number</th>
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<tr>
<td>401-4580-66L</td>
<td>Characteristic Classes and Elliptic Genus</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>Q. Chen, G. Felder</td>
</tr>
</tbody>
</table>

Abstract
Characteristic classes, spin structures and Dirac operator, applications of the Atiyah-Singer index theorem, elliptic genus and modular forms.

Objective
- Knowledge of methods and algorithms commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning

Content
- Characteristic classes, spin structures and Dirac operators, applications of the Atiyah-Singer index theorem, elliptic genus and modular forms.
- Tentative Syllabus
  1. Vector bundles and differential forms (1 lectures)
  2. Basics for Characteristic classes such as Stiefel-Whitney classes, Wu Classes, Chern Classes and Pontryagin classes (3 lectures)
  3. Spin structures and Dirac operators (2 lectures)
  4. Atiyah-Singer Index theorem and its application (1-2 lectures)
  5. Multiplicative sequences and various genera (1 lecture)
  6. Elliptic genus and modular forms (1 lecture)
  7. Miraculous cancellation formulas for Hirzebruch L genus (1 lecture)
  8. Miscellaneous topics (1 lecture)

Literature
1. Characteristic Classes by Milnor
2. Differential Forms in Algebraic Topology by Bott & Tu
3. Manifolds and Modular Forms by Hirzebruch, Berger and Jung

Prerequisites / notice
Prerequisite: Algebraic Topology.

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<th>Number</th>
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<tr>
<td>401-3570-66L</td>
<td>Algebraic Number Theory</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>J. Fresán</td>
</tr>
</tbody>
</table>

Abstract
Much of the progress in algebraic number theory aimed at solving concrete Diophantine equations. At the heart of the problem lies the fact that the ring of integers of a number field does not have unique factorization. The "class group" measures how much this property fails. The seminar will present basic results around this invariant, including finiteness and the relation to zeta functions.
The following topics will be covered:

- The quadratic reciprocity law
- The geometry of numbers
- Integral quadratic forms
- Number fields and rings of integers
- Finiteness of the class number
- Unique factorization of ideals
- The Dedekind zeta function of a number field and the class number formula

The seminar will be (probably) followed by a more advanced course on Class Field Theory on the Spring Semester. Our basic reference will be chapters I and VII of Neukirch's book "Algebraic number theory" (Grundlehren Math. Wiss. 322. Springer-Verlag, Berlin, 1999). Additional references will be given at the beginning of the seminar.

Basic knowledge of algebraic structures (groups, rings, fields) and Galois theory, at the level of Algebra I and II. More advanced topics will be explained when needed.

**401-3180-66L**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Prerequisites / notice</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homological Algebra</td>
<td>Basic concepts of homological algebra, homology and cohomology of groups.</td>
<td>W</td>
<td>4</td>
<td>2S</td>
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</table>

**401-4600-66L**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Prerequisites / notice</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Seminar in Probability</td>
<td>The seminar is centered around a topic in probability theory which changes each semester.</td>
<td>W</td>
<td>4</td>
<td>2S</td>
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**401-3640-66L**

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<th>Course Title</th>
<th>Prerequisites / notice</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor(s)</th>
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</thead>
<tbody>
<tr>
<td>Monte Carlo and Quasi-Monte Carlo Methods: Mathematical and Numerical Analysis</td>
<td>Prerequisites: Completed courses Numerical Analysis of Elliptic/ Parabolic PDEs, or Numerical Analysis of Hyperbolic PDEs, or Numerical Analysis of Stochastic ODEs, and FAI, Probability Theory I.</td>
<td>W</td>
<td>4</td>
<td>2S</td>
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</table>

**401-3650-66L**

<table>
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<tr>
<th>Course Title</th>
<th>Prerequisites / notice</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numerical Analysis Seminar: Measure Theoretic Tools for Analyzing and Approximating Nonlinear PDEs</td>
<td>- To read and understand a research paper and present it in an understandable way to other students.</td>
<td>W</td>
<td>4</td>
<td>2S</td>
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</table>

**Literature**


Semester Papers help to deepen the students' knowledge of a specific subject area. Students are offered a selection of topics. These

<table>
<thead>
<tr>
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<th>ECTS</th>
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<tbody>
<tr>
<td>Mean Field Games</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>R. Alaifari</td>
</tr>
<tr>
<td></td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>M. Burzoni, M. Soner</td>
</tr>
</tbody>
</table>

Abstract

The analysis of differential games with a large number of players finds applications in various research fields, from physics to economics and finance. The aim of Mean Field Games theory is to provide a suitable approximation of such problems with a higher tractability.

Objective

This course aims to give a broad understanding of the basic ideas of Mean Field Games, the main mathematical tools and the possible applications.

Content

We first present and analyze toy models of Mean Field Games in order to familiarize with the subject and to understand what kind of problems can be solved with this theory.

We explore two different approaches to Mean Field Games. From an analytic point of view it consists of a coupled system of PDEs. From a probabilistic point of view it amounts to a particular type of stochastic differential equations.

Literature

1) Notes on Mean Field Games. P. Cardaliaguet
2) Mean Field Games. J.M. Lasry, P.L. Lions
3) Probabilistic theory of Mean Field Games and applications. R. Carmona, F. Delarue

Prerequisites / notice

Basic knowledge of stochastic analysis including Brownian Motion and stochastic differential equations.

Semester Papers

There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

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<tr>
<th>Number</th>
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<tr>
<td>401-3750-01L</td>
<td>Semester Paper</td>
<td>W</td>
<td>8</td>
<td>11A</td>
<td>Professors</td>
</tr>
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</table>

Abstract

Semester Papers help to deepen the students' knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students' ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice

There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

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<tr>
<td>401-3750-02L</td>
<td>Semester Paper</td>
<td>W</td>
<td>8</td>
<td>11A</td>
<td>Professors</td>
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Abstract

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Prerequisites / notice

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<tr>
<td>401-3750-03L</td>
<td>Semester Paper</td>
<td>W</td>
<td>8</td>
<td>11A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract

Semester Papers help to deepen the students' knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students' ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice

There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

GESS Science in Perspective

Recommended Science in Perspective (Type B) for D-MATH.

see Science in Perspective: Type A: Enhancement of Reflection Capability

see Science in Perspective: Language Courses ETH/UZH

Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2000-00L</td>
<td>Scientific Works in Mathematics</td>
<td>O</td>
<td>0</td>
<td></td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

Target audience:
Third year Bachelor students:
Master students who cannot document to have received an adequate training in working scientifically.
Mandatory for all Bachelor and Master students with matriculation in the autumn semester 2014 or later.

Directive

Abstract
Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)

Objective
Learn the basic standards of scientific works in mathematics.

Content
- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519

Prerequisites / notice
This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

401-4990-00L Master's Thesis
Only students who fulfill the following criteria are allowed to begin with their master's thesis:
- successful completion of the bachelor programme;
- fulfilling of any additional requirements necessary to gain admission to the master programme.

No direct enrolment to this course unit in myStudies. Please fill in the online application form. Requirements and application form under https://www.math.ethz.ch/intranet/students/study-administration/theses.html
(Afterwards the enrolment will be done by the Study Administration.)

Abstract
The master's thesis concludes the study programme. Writing up the master's thesis allows students to independently produce a major piece of work on a mathematical topic. It generally involves consulting the literature, solving any ensuing problems, and putting together the results in writing.

► Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
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<tr>
<td>401-5000-00L</td>
<td>Zurich Colloquium in Mathematics</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>W. Werner, P. L. Bühlmann, M. Burger, S. Mishra, R. Pandharipande, University lecturers</td>
</tr>
<tr>
<td>401-5990-00L</td>
<td>Zurich Graduate Colloquium (University of Zurich)</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>University lecturers</td>
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</tbody>
</table>

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
The Graduate Colloquium is an informal seminar aimed at graduate students and postdocs whose purpose is to provide a forum for communicating one's interests and thoughts in mathematics.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>401-5350-00L</td>
<td>Analysis Seminar</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>M. Struwe, A. Carlotto, D. Christodoulou, F. Da Lio, A. Figalli, N. Hungerbühler, T. Ilmanen, T. Kappeler, T. Rivière, D. A. Salamon</td>
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<td>401-5530-00L</td>
<td>Geometry Seminar</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>M. Burger, M. Einsiedler, U. Lang, University lecturers</td>
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<tr>
<td>401-5580-00L</td>
<td>Symplectic Geometry Seminar</td>
<td>E-</td>
<td>0</td>
<td>2K</td>
<td>D. A. Salamon, P. Biran, A. Cannas da Silva</td>
</tr>
<tr>
<td>401-5330-00L</td>
<td>Talks in Mathematical Physics</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>A. Cattaneo, G. Felder, M. Gaberdiel, G. M. Graf, H. Knörrer, T. H. Willwacher, University lecturers</td>
</tr>
<tr>
<td>401-5600-00L</td>
<td>Seminar on Stochastic Processes</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>J. Bertoin, A. Nikeghbali, P. Nolin, B. D. Schlein, A.S. Sznitman, W. Werner</td>
</tr>
</tbody>
</table>

Abstract
Research colloquium

Abstract  Research colloquium


Abstract  About 5 talks on applied statistics.
Objective  See how statistical methods are applied in practice.
Content  There will be about 5 talks on how statistical methods are applied in practice.
Prerequisites / notice  This is no lecture. There is no exam and no credit points will be awarded. The current program can be found on the web: http://stat.ethz.ch/events/zukost
Course language is English or German and may depend on the speaker.

401-5910-00L  Talks in Financial and Insurance Mathematics  E-  0 credits  1K  P. Cheridito, M. Schweizer, M. Soner, J. Teichmann, M. V. Wüthrich

Abstract  Research colloquium
Content  Regular research talks on various topics in mathematical finance and actuarial mathematics

401-5900-00L  Optimization Seminar  E-  0 credits  1K  R. Weismantel, R. Zenklusen

Abstract  Lectures on current topics in optimization
Objective  Expose graduate students to ongoing research activities (including applications) in the domain of optimization.
Content  This seminar is a forum for researchers interested in optimization theory and its applications. Speakers are expected to stimulate discussions on theoretical and applied aspects of optimization and related subjects. The focus is on efficient algorithms for continuous and discrete optimization problems, complexity analysis of algorithms and associated decision problems, approximation algorithms, mathematical modeling and solution procedures for real-world optimization problems in engineering, industries, public sectors etc.

401-5960-00L  Colloquium on Mathematics, Computer Science, and Education  E-  0 credits  0 credits  N. Hungerbühler, M. Akveld, J. Hromkovic, H. Klemenz

Subject didactics for mathematics and computer science teachers.
Didactics colloquium

Abstract  Research colloquium
Objective  Didactics colloquium
Prerequisites / notice  Occasionally, talks may be delivered in German.


Abstract  Research colloquium
Objective  The Zurich Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.


Abstract  Research colloquium
Objective  The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.

251-0100-00L  Computer Science Colloquium  E-  0 credits  2K  Lecturers

Abstract  Invited talks, covering the entire scope of computer science. External Listeners are welcome at no charge. A detailed schedule is published at the beginning of each semester.
Objective  Top international computer scientists take the floor at the distinguished computer science colloquium. Our guest speakers present impacting topics across various areas of the discipline. The colloquium series is held every semester and also includes inaugural and farewell lectures of the department's professors. The colloquium is a noteworthy event for all graduate students. Outside attendance is equally welcome.
Content  Eingeladene Vorträge aus dem gesamten Bereich der Informatik, zu denen auch Auswärtige kostenlos eingeladen sind. Zu Semesterbeginn erscheint jeweils ein ausführliches Programm.

252-4202-00L  Seminar in Theoretical Computer Science  E-  2 credits  2S  E. Welzl, B. Gärtnер, M. Hoffmann, J. Lengler, A. Steger, B. Sudakov

Abstract  Presentation of recent publications in theoretical computer science, including results by diploma, masters and doctoral candidates.
Objective  The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.
406-2004-AAL  Algebra II

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Galois theory and Representations of finite groups, algebras.

The precise content changes with the examiner. Candidates must therefore contact the examiner in person before studying the material.

Objective
Introduction to fundamentals of Galois theory, and representation theory of finite groups and algebras

Content
Fundamentals of Galois theory
Representation theory of finite groups and algebras

Lecture notes
For a summary of the content and exercises with solutions of my lecture course in FS2016 see: https://www2.math.ethz.ch/education/bachelor/lectures/fs2016/math/algebra2/

Literature
S. Lang, Algebra, Springer Verlag
B.L. van der Waerden: Algebra I und II, Springer Verlag
I.R. Shafarevich, Basic notions of algebra, Springer verlag
G. Mislin: Algebra I, vdf Hochschulverlag
U. Stammbach: Algebra, in der Polybuchhandlung erhältlich
G. Wüstholz, Algebra, vieweg-Verlag, 2004
J-P. Serre, Linear representations of finite groups, Springer Verlag

Prerequisites / notice
Algebra I

406-2005-AAL  Algebra I and II

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction and development of some basic algebraic structures - groups, rings, fields including Galois theory, representations of finite groups, algebras.

The precise content changes with the examiner. Candidates must therefore contact the examiner in person before studying the material.

Content
Basic notions and examples of groups;
Subgroups, Quotient groups and Homomorphisms,
Group actions and applications

Basic notions and examples of rings;
Ring Homomorphisms,
ideals, and quotient rings, rings of fractions
Euclidean domains, Principal ideal domains, Unique factorization domains

Basic notions and examples of fields;
Field extensions, Algebraic extensions, Classical straight edge and compass constructions

Fundamentals of Galois theory
Representation theory of finite groups and algebras

Lecture notes
For a summary of the content and exercises with solutions of my lecture courses in HS2015 and FS2016 see: https://www2.math.ethz.ch/education/bachelor/lectures/hs2015/math/algebra1/index-2.html
https://www2.math.ethz.ch/education/bachelor/lectures/fs2016/math/algebra2/

Literature
S. Lang, Algebra, Springer Verlag
B.L. van der Waerden: Algebra I und II, Springer Verlag
I.R. Shafarevich, Basic notions of algebra, Springer verlag
G. Mislin: Algebra I, vdf Hochschulverlag
U. Stammbach: Algebra, in der Polybuchhandlung erhältlich
G. Wüstholz, Algebra, vieweg-Verlag, 2004
J-P. Serre, Linear representations of finite groups, Springer Verlag

406-2303-AAL  Complex Analysis

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, analytic continuation, conformal mappings, Riemann mapping theorem.

Literature
B. Palka: "An introduction to complex function theory."
R.Remmert: Theory of Complex Functions,. Springer Verlag
E.Hille: Analytic Function Theory. AMS Chelsea Publication

406-2284-AAL  Measure and Integration

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract

Literature
B. Palka: "An introduction to complex function theory."
R.Remmert: Theory of Complex Functions,. Springer Verlag
E.Hille: Analytic Function Theory. AMS Chelsea Publication

Prerequisites / notice
Algebra I
**Abstract**

Introduction to the abstract measure theory and integration, including the following topics: Lebesgue measure and Lebesgue integral, Lp-spaces, convergence theorems, differentiation of measures, product measures (Fubini's theorem), abstract measures, Radon-Nikodym theorem, probabilistic language.

**Objective**

Basic acquaintance with the theory of measure and integration, in particular, Lebesgue's measure and integral.

**Literature**

1. Lecture notes by Professor Michael Struwe (http://www.math.ethz.ch/~struwe/Skripten/AnalysisIII-SS2007-18-4-08.pdf)
2. L. Evans and R.F. Gariepy "Measure theory and fine properties of functions"
3. Walter Rudin "Real and complex analysis"
4. R. Bartle The elements of Integration and Lebesgue Measure

**406-2554-AAL**

**Topography**

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Abstract**

Topological spaces, continuous maps, connectedness, compactness, separation axioms, metric spaces, quotient spaces, homotopy, fundamental group and covering spaces, van Kampen Theorem, surfaces and manifolds.

**Literature**

Klaus Jänich: Topologie (Springer-Verlag)
http://www.springerlink.com/content/978-3-540-21393-2/fulltext/#section=592889&page=1
James Munkres: Topology (Prentice Hall)
William Massey: Algebraic Topology: an Introduction (Springer-Verlag)
Alan Hatcher: Algebraic Topology (Cambridge University Press)
http://www.math.cornell.edu/~hatcher/AT/ATpage.html

**Prerequisites / notice**

The precise content changes with the examiner. Candidates must therefore contact the examiner in person before studying the material.

**406-2604-AAL**

**Probability and Statistics**

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Abstract**

Introduction to probability and statistics with many examples, based on chapters from the books "Probability and Random Processes" by G. Grimmett and D. Stirzaker and "Mathematical Statistics and Data Analysis" by J. Rice. In addition to a mathematically rigorous treatment, also an intuitive understanding and familiarity with the ideas behind the definitions are emphasized. Measure theory is not used systematically, but it should become clear why and where measure theory is needed.

**Content**

Probability:
- Chapters 1-5 (Probabilities and events, Discrete and continuous random variables, Generating functions) and Sections 7.1-7.5 (Convergence of random variables) from the book "Probability and Random Processes". Most of this material is also covered in Chap. 1-5 of "Mathematical Statistics and Data Analysis"; on a slightly easier level.

Statistics:
- Sections 8.1 - 8.5 (Estimation of parameters), 9.1 - 9.4 (Testing Hypotheses), 11.1 - 11.3 (Comparing two samples) from "Mathematical Statistics and Data Analysis".

**Literature**

Geoffrey Grimmett and David Stirzaker, Probability and Random Processes.
<table>
<thead>
<tr>
<th>Key for Hours</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
D. Neri, D. Neri

Students know and understand:

This course will be a combination of formal lectures, group discussions and self-directed studies. Course material will be taught through

S. Russmann

The course advances basic knowledge in pharmacology and toxicology. Special emphasis is placed on the interrelationship between

2 credits

Type

- Historical landmarks of drug safety

O

- A script is provided for each lecture course. The scripts define important and exam-relevant contents of lectures. Scripts do not replace the

- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)

Objectives:

- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)

Topics include the pharmacology and pharmacotherapy of infectious diseases and cancer. In the field of pharmacogenomics, the course is

Handouts to the lectures will be available for downloading under http://www.pharma.ethz.ch/scripts/index

M. Detmar

Drug Seminars I

O

Hours

The course consists of two parts:

ECTS

Introduction to the principles, methods and applications of pharmacoepidemiology and drug safety. Drug safety in the pharmaceutical

Recommended reading:

- Strom, Kimmel, Hennessy: Textbook of Pharmacoepidemiology

- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)

- Interactive discussion of many real-life examples for each topic

- Pharmacoepidemiological databases, 'Big Data'

- Clinical Decision Support Systems, Interventional Pharmacoepidemiology

- Medication errors, clinical pharmacology / clinical pharmacy

- Pharmacoepidemiology and regulatory decision making in drug safety; Risk management plans (RMPs)

- Descriptive, cohort and case-control drug safety study designs; Data analysis and control of confounding

- Pharmacoepidemiology and regulatory decision making in drug safety; Risk management plans (RMPs)

- Medication errors, clinical pharmacology / clinical pharmacy

- Pharmacoepidemiological databases, 'Big Data'

- Interactive discussion of many real-life examples for each topic

- Setup of programs that can effectively reduce medication errors and improve drug safety in clinical practice, particularly in hospitals

To familiarize participants with the principle methods and applications of pharmacoepidemiology and drug safety that is relevant for industry, regulatory affairs, but also for clinical pharmacists in hospitals and office pharmacies.

To perform independently a causality assessment of suspected adverse drug reactions in patients

- Study designs and biostatistics used for the quantitative evaluation of drug safety

- Setup of programs that can effectively reduce medication errors and improve drug safety in clinical practice, particularly in hospitals

- Historical landmarks of drug safety

- Pharmacovigilance and causality assessment

- Drug safety in premarketing clinical trials

- Descriptive, cohort and case-control drug safety study designs; Data analysis and control of confounding

Pharmacoepidemiology and regulatory decision making in drug safety; Risk management plans (RMPs)

- Medication errors, clinical pharmacology / clinical pharmacy

- Clinical Decision Support Systems, Interventional Pharmacoepidemiology

- Pharmacoepidemiological databases, 'Big Data'

- Interactive discussion of many real-life examples for each topic

This course will be a combination of formal lectures, group discussions and self-directed studies. Course material will be taught through seminars, case studies in small groups.

Recommended literature

- Rothman: Introduction to Epidemiology

- Strom, Kimmel, Hennessy: Textbook of Pharmacoepidemiology

6 credit points are awarded after successful presentation
Drug therapy is nothing less than interference with a highly complex biological system, which is affected by various internal and external factors. A profound understanding of drug effects thus requires a transdisciplinary approach of investigation. The drug seminars provide a platform for the presentation and discussion of these transdisciplinary approaches for the investigation of drug action.

Drug therapy is nothing less than interference with a highly complex biological system, which is affected by various internal and external factors. A profound understanding of drug effects thus requires a transdisciplinary approach of investigation. The drug seminars provide a platform for the presentation and discussion of these transdisciplinary approaches for the investigation of drug action.
Gaining insight into the glycobiology of therapeutically used glycoproteins. This implies knowing and understanding protein-based drugs constitute around 25% of new approvals and most of them are glycoproteins. Using selected examples the course aims at providing insight into our present knowledge on glycosylation-activity relationships and the production and analysis of glycoprotein-based drugs.

Objective
- The major types of protein-linked glycans and their biosynthesis
- The most important expression systems for production of recombinant glycoproteins
- Methods used to alter or manipulate glycosylation
- The most clinically used glycoproteins and how glycosylation influences their therapeutic profile.
- Current methods for the qualitative and quantitative characterization of glycoproteins and being able to apply this knowledge in other contexts.

Content
- Protein-based drugs
- Glycobiology in Drug Development

Literature

Prerequisites / notice
- Requirements: Basic knowledge in immunology, molecular biology, protein chemistry and analytics. Basic knowledge in pharmacology.

Compensatory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>535-0300-00L</td>
<td>Glycobiology in Drug Development</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>V. I. Otto</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Protein-based drugs constitute around 25% of new approvals and most of them are glycoproteins. Using selected examples the course aims at providing insight into our present knowledge on glycosylation-activity relationships and the production and analysis of glycoprotein-based drugs.</td>
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<tbody>
<tr>
<td>535-0300-00L</td>
<td>Molecular Mechanisms of Drug Actions and Targets</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>V. I. Otto</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>On average one drug per year is withdrawn from the market. Using selected examples of such drug failures, the course aims at analyzing and discussing the present explanations of drug actions as well as the design and predictive power of animal models and clinical trials. In addition, the ethical, societal, and economical expectations in new drugs shall be reflected.</td>
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<th>Lecturers</th>
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<tr>
<td>535-03-00L</td>
<td>Computer-Assisted Drug Design</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>G. Schneider</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>The lecture series provides an introduction to computer applications in medicinal chemistry. A focus is on molecular representations, property predictions, molecular similarity concepts, virtual screening techniques, and de novo drug design. All theoretical concepts and algorithms presented are illustrated by practical applications and case studies.</td>
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<td>851-0180-00L</td>
<td>Research Ethics</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>G. Achermann</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.</td>
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Data: 06.11.2018 12:57 | Autumn Semester 2016 | Page 1170 of 1571
Objective

The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.

Content

I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes

Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.
Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students’ technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Objective

Discovering Management combines in an innovative format a set of lectures and an advanced business game. The learning model for Discovering Management involves ‘learning by doing’. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organisation as if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students’ understanding of factors driving innovation, entrepreneurship, and company success.

Content

Discovering Management aims to broaden the students’ understanding of the principles of business management, emphasizing the interdependence of various topics in the development and management of a firm. The lectures introduce students not only to topics relevant for managing large corporations, but also touch upon the different aspects of starting up your own venture. The lectures will be presented by the respective area specialists at D-MTEC.

The course broadens the view and understanding of technology by linking it with its commercial applications and with society. The lectures are designed to introduce students to topics related to strategy, corporate innovation, leadership, corporate and entrepreneurial finance, value chain analysis, corporate social responsibility, and business model innovation. Practical examples from industry experts will stimulate the students to critically assess these issues. Creative skills will be trained by the business game exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of Chief Innovation Officer of a large multinational company. As they learn more about the specific case and identify the challenge they are faced with, the students will have to develop an innovative business case for this multinational corporation. Doing so, this exercise will provide an insight into the context of managerial problem-solving and corporate innovation, and enhance the students’ appreciation for the complex tasks companies and managers deal with.

The business game presents a realistic model of a company and provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyse the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

Prerequisites / notice

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

**Research Project**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tr>
<td>511-0001-00L</td>
<td>Research Project</td>
<td>O</td>
<td>10</td>
<td>20A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract

The Research Project accustoms students to scientific work.

Objective

Students are accustomed to scientific work and they get to know one specific research field.

Content

Students work on a current field of research.

**Master’s Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>511-0002-00L</td>
<td>Master’s Thesis</td>
<td>O</td>
<td>30</td>
<td>40D</td>
<td>Lecturers</td>
</tr>
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</table>

Abstract

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a subject area of Pharmaceutical Sciences as chosen by the student.

**GESS Science in Perspective**

Recommended GESS Science in Perspective (Type B) for D-CHAB.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UEH

**Course Units for Additional Admission Requirements**

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>406-0603-AAL</td>
<td>Stochastics (Probability and Statistics)</td>
<td>E</td>
<td>4</td>
<td>9R</td>
<td>M. Kalisch</td>
</tr>
</tbody>
</table>

Any other students (e.g. incoming exchange students,
The objective of this course is to build a solid foundation in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 4: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student's t Distribution
Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435

From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/

**551-0103-AAL** Fundamentals of Biology II: Cell Biology

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

The goal of the course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signalling, embryonic development and cancer research.

**Literature**


**535-0135-AAL** Clinical Chemistry I

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Introduction into fundamentals of laboratory diagnostics and overview of the laboratory parameters concerning inflammation, lipid metabolism, myocardial infarction, diabetes, kidney function, urinary diagnostics, liver function, blood coagulation, blood count, therapeutic drug monitoring and drugs of abuse screening.

Overview of the possibilities and limitations in clinical laboratory diagnostics. Indications and methods of everyday parameters are known.

Introduction into medical laboratory diagnostics: immunochemical methods, diagnostics of inflammation, acute myocardial infarction, lipid metabolism, diabetes, kidney function and urinary diagnostics, blood coagulation, blood count, therapeutic drug monitoring, drugs of abuse screening, common diagnostics of liver diseases, point-of-care diagnostics.
535-0222-AAL  Pharmaceutical Analytics  E-  4 credits  9R  C. Steuer

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract

Theoretical and practical comprehension of analytical chemistry in order to solve pharmaceutical problems.

Objective

Knowledge in Pharmaceutical Analytics in order to solve fundamental analytical problems. Handling of the most important pharmaceupical texts and monographs.

Content

Introduction in Pharmaceutical Analytics. Theoretical and practical considerations concerning a lot of methods in different Pharmacopeias. Identification, purity testing, stability testing, assays of drugs and drug formulations.

Lecture notes

A script can be purchased at the HCI-Shop, HCI-Building, D floor.

Literature

David G. Watson, Pharmaceutical Analysis, Elsevier.

535-0241-AAL  Biopharmacy  E-  3 credits  6R  S.D. Krämer

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract

Introduction to the Basics in Biopharmacy. Pharmacokinetic processes (absorption, distribution, metabolism and excretion, ADME), which determine the fate of a drug in the body. Knowledge of the most important pharmacokinetic parameters. Interpretation of concentration-time-profiles of drugs. Pharmacokinetic profiling of drugs in view of therapy optimization and analysis of interaction potential.

Objective

Fundamentals of Biology II: Microbiology


Fundamentals of Biology II: Biochemistry and Molecular Biology

Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycans, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.

Literature


Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract

Water balance, assimilation, transport in plants; developmental biology, stress physiology.

Objective


Lecture notes

none

Literature


Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract

Structural, function, genetics of prokaryotic microorganisms and fungi.

Objective


Lecture notes

none

Literature


Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

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Objective


Lecture notes

none

Literature


Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

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Abstract

The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.

Objective

Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycans, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.

Lecture notes

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Literature


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<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
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<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<td>Z</td>
<td>Courses outside the curriculum</td>
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<td>Dr</td>
<td>Suitable for doctorate</td>
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**Key for Hours**

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<tr>
<th>V</th>
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<td>lecture with exercise</td>
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<td>U</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

**ECTS**

- European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Micro- and Nanosystems Master

Core Courses

Devices and Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0197-00L</td>
<td>Wearable Systems I</td>
<td>W+</td>
<td>6</td>
<td>4G</td>
<td>G. Tröster, U. Blanke</td>
</tr>
</tbody>
</table>

Objective

Context recognition in mobile communication systems like mobile phone, smart watches and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

Content

Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our 'smart phone' detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our 'smart phone' offers us the appropriate services like a personal assistant. Context comprises user's behavior, his activities, his local and social environment.

The main topics of the course include

- Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarity measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, kNN-Methods, Support Vector Machine, AdaBoost, Deep Learning), clustering (k-means, dbscan, topic models), Recommender Systems, Collaborative Filtering, Crowdsourcing.

The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

Prerequisites / notice

No special prerequisites

Lecture notes

Language: german/english (depending on the participants)

Lecture notes for all lessons, assignments and solutions.

http://www.ife.ee.ethz.ch/education/wearable_systems_1

Literature

No special prerequisites

227-0166-00L Analog Integrated Circuits W+ 6 credits 2V+2U Q. Huang

Objective

Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems.

The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.

Content

Review of bipolar and MOS devices and their small-signal equivalent circuit models. Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers; differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits. The exercise sessions aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is used to facilitate the tasks. There is also an experimental session on op-amp measurements.

Lecture notes

Handouts of presented slides. No script but accompanying textbook is recommended.

Literature


Energy Conversion and Quantum Phenomena

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
</table>
| 402-0595-00L | Semiconductor Nanostructures W+ 6 credits 2V+1U T. M. Ihn

Objective

At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures:

1. The integer quantum Hall effect
2. Conductance quantization in quantum point contacts
3. the Aharonov-Bohm effect
4. Coulomb blockade in quantum dots
Content
1. Introduction and overview
2. Semiconductor crystals: Fabrication and band structures
3. k-p-theory, effective mass
4. Envelope functions and effective mass approximation, heterostructures and band engineering
5. Fabrication of semiconductor nanostructures
6. Electrostatics and quantum mechanics of semiconductor nanostructures
7. Heterostructures and two-dimensional electron gases
8. Drude Transport
9. Electron transport in quantum point contacts; Landauer-Büttiker description
10. Ballistic transport experiments
11. Interference effects in Aharonov-Bohm rings
12. Electron in a magnetic field, Shubnikov-de Haas effect
13. Integer quantum Hall effect
14. Coulomb blockade and quantum dots

Lecture notes

Literature
In addition to the lecture notes, the following supplementary books can be recommended:

Prerequisites / notice
The lecture is suitable for all physics students beyond the bachelor of science degree. Basic knowledge of solid state physics is recommended. Very ambitioned students in the third year may be able to follow. The lecture can be chosen as part of the PhD-program. The course is taught in English.

Material, Surfaces and Properties

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<tr>
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<tr>
<td>151-0524-00L</td>
<td>Continuum Mechanics I</td>
<td>W+</td>
<td>4 credits</td>
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<td>E. Mazza</td>
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<td>that are relevant for design and calculation</td>
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<td>of structures. These include anisotropic</td>
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<td>linear elasticity, linear viscoelasticity,</td>
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<td>theories and laminate theory are presented.</td>
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<td>Theoretical models are complemented by</td>
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<td>examples of engineering applications and</td>
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<td>experiments.</td>
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<td>Objective</td>
<td>Basic theories for solving continuum</td>
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<td>mechanics problems of engineering</td>
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<td>applications, with particular attention to</td>
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<td>material models.</td>
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<td>Content</td>
<td>Anisotrope Elastizität, Linearelastisches</td>
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<td>und linearksviskoses Stoffverhalten,</td>
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<td>viskoelastizität, mikro-makro Modellierung,</td>
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<td>Experimenten.</td>
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<tr>
<td>Lecture notes</td>
<td>Script Download:</td>
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<td><a href="https://www.ethz.ch/content/specialinterest/">https://www.ethz.ch/content/specialinterest/</a></td>
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<tr>
<td>327-0505-00L</td>
<td>Surfaces, Interfaces and their Applications I</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>N. Spencer, M. P. Heuberger, L. Isa</td>
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<td>Abstract</td>
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<td>chemical principles and importance of</td>
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<td>introduced to the most important techniques</td>
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<td>that can be used to characterize surfaces.</td>
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<td>of tribology (friction, lubrication, and</td>
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<td>wear) and corrosion.</td>
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<td>and chemical principles, as well as the</td>
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<td>tools and applications of surface science,</td>
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<td>and to be able to choose appropriate</td>
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<td>surface-analytical approaches for solving</td>
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<td>problems.</td>
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<tr>
<td>Content</td>
<td>Introduction to Surface Science</td>
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<td>Physical Structure of Surfaces</td>
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<td>Surface Forces (static and dynamic)</td>
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<td>Adsorbates on Surfaces</td>
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<td></td>
<td>Surface Thermodynamics and Kinetics</td>
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<td></td>
<td>The Solid-Liquid Interface</td>
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<td>Electron Spectroscopy</td>
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<td>Vibrational Spectroscopy on Surfaces</td>
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<td></td>
<td>Scanning Probe Microscopy</td>
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<tr>
<td>Lecture notes</td>
<td>Script Download:</td>
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<td><a href="https://www.ethz.ch/content/specialinterest/">https://www.ethz.ch/content/specialinterest/</a></td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0509-00L</td>
<td>Microscale Acoustofluidics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>J. Dual</td>
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<tr>
<td>Abstract</td>
<td>Number of participants limited to 30.</td>
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<tr>
<td>Objective</td>
<td>In this lecture the basics as well as</td>
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<td>practical aspects (from modelling to</td>
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<td>design and fabrication) are described</td>
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<td>from a solid and fluid mechanics</td>
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<td>perspective with applications to</td>
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<td>microsystems and lab on a chip devices.</td>
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<tr>
<td>Content</td>
<td>Understanding acoustophoresis, the design</td>
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<td>of devices and potential applications</td>
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<tr>
<td>Lecture notes</td>
<td>Yes, incl. Chapters from the Tutorial:</td>
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<tr>
<td></td>
<td>Microscale Acoustofluidics, T. Laurell and</td>
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<tr>
<td>Literature</td>
<td>Microscale Acoustofluidics, T. Laurell and</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.</td>
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Modelling and Simulation

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-2037-00L</td>
<td>Physical Modelling and Simulation</td>
<td>W+</td>
<td>5 credits</td>
<td>4G</td>
<td>C. Hafner, J. Leuthold, J. Smajic</td>
</tr>
</tbody>
</table>
Abstract
This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

Objective
Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.

Content
The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, linear equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetical-thermal analysis of MEMS.

In the second part of the course the students work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.

151-0107-20L High Performance Computing for Science and Engineering (HPCSE I)

Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

Class notes, handouts

>>> Laboratory Course

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0620-00L</td>
<td>Embedded MEMS Lab</td>
<td>W+</td>
<td>5</td>
<td>3P</td>
<td>C. Hierold, S. Blunier, M. Haluska</td>
</tr>
</tbody>
</table>

Abstract
Practical course: Students are introduced to the process steps required for the fabrication of MEMS (Micro Electro Mechanical System) and can carry out the fabrication and testing steps in the clean rooms by themselves. Additionally, they learn the requirements for working in clean rooms. Processing and characterization will be documented and analyzed in a final report. Limited access

Objective
Students learn the individual process steps that are required to make a MEMS (Micro Electro Mechanical System). Students carry out the process steps themselves in laboratories and clean rooms. Furthermore, participants become familiar with the special requirements (cleanliness, safety, operation of equipment and handling hazardous chemicals) of working in the clean rooms and laboratories. The entire production, processing, and characterization of the MEMS is documented and evaluated in a final report.

Content
With guidance from a tutor, the individual silicon microsystem process steps that are required for the fabrication of an accelerometer are carried out:
- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Packaging and electrical connection of a MEMS device
- Testing and characterization of the MEMS device
- Written documentation and evaluation of the entire production, processing and characterization

Lecture notes
A document containing theory, background and practical course content is distributed at the first meeting of the course.

Prerequisites / notice
The document provides sufficient information for the participants to successfully participate in the course.

Participating students are required to attend all scheduled lectures and meetings of the course.

Participating students are required to provide proof that they have personal accident insurance prior to the start of the laboratory portion of the course.

This master's level course is limited to 15 students per semester for safety and efficiency reasons. If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

Priority 1: master students of the master's program in "Micro and Nanosystems"
Priority 2: master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering (MAVT-tutors Profs Daoio, Dual, Hierold, Koumoutsakos, Nelson, Norris, Park, Poulikakos, Pratsinis, Stemmer), who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

Priority 3: master students, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

Priority 4: all other students (PhD, bachelor, master) with a background in silicon or microsystems process technology.

If there are more students in one of these priority groups than places available, we will decide by drawing lots. Students will be notified at the first lecture of the course (introductory lecture) as to whether they are able to participate.

The course is offered in autumn and spring semester.
### 151-0255-00L Energy Conversion and Transport in Biosystems

**Abstract**
Theory and application of thermodynamics and energy conversion in biological systems with focus on the cellular level.

**Objective**
- Mass transfer models for the transport of chemical species in the human cell.
- Organization and function of the cell membrane and of the cell cytoskeleton.
- The role of molecular motors in cellular force generation and function in cell migration.

**Content**
- Topics are treated in 2 blocks:
  - (I) From Quantum to Continuum
  - (II) Interaction Forces on the Micro and Nano Scale

**Literature**

**Prerequisites / notice**
- Course format: Lectures and Mini-Review presentations: Thursday 10-13, ML F 36
- Homework: Mini-Reviews
- Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

### 402-0572-00L Aerosols I: Physical and Chemical Principles

**Abstract**
Aerosols deals with basic physical and chemical properties of aerosol particles. The importance of aerosols in the atmosphere and in other fields is discussed.

**Objective**
- Knowledge of basic physical and chemical properties of aerosol particles and their importance in the atmosphere and in other fields
- Physical and chemical properties of aerosols, aerosol dynamics (diffusion, coagulation...), optical properties (light scattering, -absorption, -extinction), aerosol production, physical and chemical characterization.

**Content**
- Aerosol production, physical and chemical characterization.
- Self-assembly and directed assembly of 2D and 3D structures.

**Literature**

### 151-0650-00L Nanosystems

**Abstract**
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

**Objective**
- Special emphasis on the emerging field of molecular electronic devices.
- The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

**Content**
- Special emphasis is placed on the emerging field of molecular electronic devices, their working principles, applications, and how they may be assembled.
- Topics are treated in 2 blocks:
  - (I) From Quantum to Continuum
  - (II) Interaction Forces on the Micro and Nano Scale

**Literature**

**Prerequisites / notice**
- Course format: Lectures and Mini-Review presentations: Thursday 10-13, ML F 36
- Homework: Mini-Reviews
- Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.
and catalysis. Methods which are covered embrace: Gas adsorption and surface area analysis, IR-Spectroscopy, X-ray diffraction, X-ray photoelectron spectroscopy, X-ray absorption, solid state NMR, Electron Microscopy and others.

529-0643-00L Process Design and Development

<table>
<thead>
<tr>
<th>Objective</th>
<th>Content</th>
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<tbody>
<tr>
<td>Basic aspects of surface science. Understanding of principles of most important experimental methods used in research concerned with surface science, material science and catalysis.</td>
<td>Methods which are covered embrace: Gas adsorption and surface area analysis, IR-Spectroscopy, X-ray diffraction, X-ray photoelectron spectroscopy, X-ray absorption, solid state NMR, Electron Microscopy and others.</td>
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</table>

<table>
<thead>
<tr>
<th>Abstract</th>
<th>Objective</th>
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<tr>
<td>The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.</td>
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<tr>
<th>Content</th>
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| Detailed Process Design: unit operation models, flash solution algorithms (different iterative methods, inside-out method), sequencing of nonideal distillation columns, networks of chemical reactors. | 

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<tr>
<th>Lecture notes</th>
<th>Literature</th>
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Prerequisites / notice

<table>
<thead>
<tr>
<th>752-3103-00L Food Rheology I</th>
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<tr>
<td>Objective</td>
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<tr>
<td>Rheology is the science of flow and deformation of matter such as polymers, dispersions (emulsions, foams, suspensions), and colloidal systems. The fluid dynamical basis, measuring techniques (rheometry), and the flow properties of different fluids (Newtonian, non-Newtonian, viscoelastic) are introduced and discussed.</td>
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<tr>
<th>Lecture notes</th>
<th>Literature</th>
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<tbody>
<tr>
<td>Notes will be handed out during the lectures.</td>
<td>Provided in the lecture notes.</td>
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Prerequisites / notice

<table>
<thead>
<tr>
<th>227-0157-00L Semiconductor Devices: Physical Bases and Simulation</th>
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<tr>
<td>Objective</td>
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<tr>
<td>The course addresses the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation. Necessary basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.</td>
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<th>Lecture notes</th>
<th>Literature</th>
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Prerequisites / notice

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<thead>
<tr>
<th>227-0225-00L Linear System Theory</th>
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<td>Objective</td>
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<tr>
<td>The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.</td>
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<th>Lecture notes</th>
<th>Literature</th>
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Prerequisites / notice

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<tr>
<th>227-0377-00L Physics of Failure and Failure Analysis of Electronic Devices and Equipment</th>
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<tr>
<td>Objective</td>
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<tr>
<td>Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.</td>
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<th>Lecture notes</th>
<th>Literature</th>
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<tbody>
<tr>
<td>Prerequisites: Control Systems I (227-0103-00) or equivalent and sufficient mathematical maturity.</td>
<td>Provided in the lecture notes.</td>
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</table>

Prerequisites / notice
Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and devices by a sequence of defined processing steps (process flow).

Objectives:
- Familiarize students with main architectural principles and concepts of embedded control systems.
- Understand the fundamental physics behind the mechanical, thermal, electric, magnetic, and optical properties of materials.
- Understand the fundamental physics behind the mechanical, thermal, electric, magnetic, and optical properties of materials.

Content:
- Introduction to rapid prototyping
- System dynamics and virtual worlds with haptic feedback
- Microfluidic fuel cells
- Hotspot targeted cooling of microprocessors
- Reuse of waste heat from supercomputers
- Introduction to fuel cells; basic principles of battery; overview of exergy analysis, single phase liquid cooling and micro-mixing; overview of multi-component-systems (mixtures) and phase equilibrium; Electrochemistry;

Lecture notes
Lecture notes, lab instructions, supplemental material

Prerequisites / notice
Prerequisite courses are Control Systems I and Informatics I.

This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: marischm@ethz.ch). After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

Detailed information can be found on the course website http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html

151-0235-00L Thermodynamics of Novel Energy Conversion Technologies

Abstract
In the framework of this course we will look at current electronic thermal and energy management strategies and novel energy conversion processes. The course will focus on component level fundamentals of these process and system level analysis of interactions among various energy conversion components.

Objective
This course deals with liquid cooling based thermal management of electronics, reuse of waste heat and novel energy conversion and storage systems such as batteries, fuel cells and micro-fuel cells. The focus of the course is on the physics and basic understanding of those systems as well as their real-world applications. The course will also look at analysis of system level interactions between a range of energy conversion components.

Content
Part 1: Fundamentals:
- Overview of exergy analysis, Single phase liquid cooling and micro-mixing;
- Thermodynamics of multi-component-systems (mixtures) and phase equilibrium;
- Electrochemistry;

Part 2: Applications:
- Basic principles of battery;
- Introduction to fuel cells;
- Reuse of waste heat from supercomputers
- Hotspot targeted cooling of microprocessors
- Microfluidic fuel cells

Part 3: System-level analysis
- Integration of the components into the system: a case study
- Analysis of the coupled operations, identification of critical states
- Support to system-oriented design

Lecture notes
Lecture slides will be made available. Lecture notes will be available for some topics (in English).

The course will be given in English:

1- Mid-term examination: Mid-term exam grade counts as 20% of the final grade.
2- Final exam: Written exam during the regular examination session. It counts as 80% of the final grade.
This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.

Content
- Fundamentals of Plasmonics
- Basic electromagnetic theory
- Optical properties of metals
- Surface plasmon polaritons on surfaces
- Surface plasmon polariton propagation
- Localized surface plasmons

Applications of Plasmonics
- Waveguides
- Extraordinary optical transmission
- Enhanced spectroscopy
- Sensing
- Metamaterials

Lecture notes
Class notes and handouts

Literature

Prerequisites / notice
Physics I, Physics II
At the beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during the whole term to analyze circuits and understand how signals propagate through them. The theory and CMOS implementation of active filters is then discussed in detail using the example of Gm-C filters and active-RC filters. The ideal and nonideal behaviour of opamps, current conveyors, and inductor simulators follows. The link to the practical design of circuits and systems is done with an overview over different quality measures and figures of merit used in scientific literature and datasheets. Finally, an introduction to discrete-time and mixed-domain filters and circuits is given, including sensor read-out amplifiers, correlated double sampling, and chopping, and an introduction to sigma-delta A/D and D/A conversion on a system level.

Lecture notes
The base for these lectures are lecture notes and two or three published scientific papers. From these papers we will together develop the technical content.

Details: https://people.ee.ethz.ch/~haschmid/asfwiki/

Some material is protected by password; students from ETHZ who are interested can write to haschmid@ethz.ch to ask for the password even if they do not attend the lecture.

Prerequisites / notice
Prerequisites: Recommended (but not required): Stochastic models and signal processing, Communication Electronics, Analog Integrated Circuits, Transmission Lines and Filters.

Knowledge of the Laplace transform and z transform and their interpretation (transfer functions, poles and zeros, bode diagrams, stability criteria ...) and of the main properties of linear systems is necessary.

**Course in continuum mechanics (mandatory), finite element method (recommended)**

### 151-0735-00L Dynamic Behavior of Materials and Structures

<table>
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<tr>
<th>Title</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>W</td>
<td>4</td>
<td>8</td>
<td>D. Mohr</td>
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</table>

**Abstract**
Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme loadings during manufacturing, crash, impact and blast events.

**Objective**
Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering.

**Content**
Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;

**Lecture notes**
Slides of the lectures, relevant journal papers and users manuals will be provided.

**Literature**
Various books will be recommended covering the topics discussed in class.

**Prerequisites / notice**
Course in continuum mechanics (mandatory), finite element method (recommended)

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**Multidisciplinary Courses**

*The students are free to choose individually from the entire course offer of ETH Zurich, ETH Lausanne and the Universities of Zurich and St. Gallen.*

**Course Catalogue of ETH Zurich**

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**GESS Science in Perspective**

*see GESS Science in Perspective: Type A: Enhancement of Reflection Capability*

*see GESS Science in Perspective: Language Courses ETH/UNI*

*Recommended GESS Science in Perspective (Type B) for D-MAVT.*

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**Semester Project**

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>151-1007-00L</td>
<td>Semester Project Micro- and Nanosystems</td>
<td>O</td>
<td>8</td>
<td>17A</td>
<td>Professors</td>
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</tbody>
</table>
Only for Micro- and Nanosystems MSc.

The subject of the Semester Project and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor.

Abstract
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

Objective
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's programme.

► Industrial Internship

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>151-1013-00L</td>
<td>Industrial Internship Micro and Nanosystems</td>
<td>O</td>
<td>8 credits</td>
<td>external organisers</td>
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</tr>
</tbody>
</table>

Abstract
The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective
The main objective of the 12-week internship is to expose master's students to the industrial work environment.

► Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1006-00L</td>
<td>Master's Thesis Micro- and Nanosystems</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

Micro- and Nanosystems Master - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Exchange Students

Courses for Exchange Students

In case the course catalogue of the upcoming semester is not available yet, please expect it to be like the year before.

You can study at ETH Zürich as an exchange student for 1 or 2 semesters, starting in the autumn or in the spring semester. Exchange students may choose courses from different curricula and years, provided that at least two thirds of all courses are taken in the ETH Zürich department they are registered in. Please be sure to coordinate your schedule with your home university.

Exam sessions and End-of-semester examinations

Like all ETH Zürich students, exchange students are obliged to sit their exams during the official examination periods. Students are requested to be present at ETH Zürich during these periods. You are therefore expected to plan your studies, internships, jobs, and financial means accordingly.

by individual arrangement

D-ITET (Exchange Students)

Electrical Engineering and Information Technology MSc

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1501-00L</td>
<td>Master's Thesis</td>
<td>Master's Thesis</td>
<td>30 credits</td>
<td>68D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

Admission only if ALL of the following apply:
- a) bachelor program successfully completed;
- b) acquired (if applicable) all credits from additional requirements for admission to master program;
- c) successfully completed both semester projects.

Note: the conditions above are not applicable to incoming exchange students.

Registration in mystudies required!
Supervisor must be a professor at D-ITET or associated, see https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html.

Abstract
The Master Program finishes with a 6-months Master Thesis which is directed by a Professor of the Department or a Professor of another Department who is associated with the D-ITET. Students gain the ability to conduct independent scientific research on a specific research problem.

Objective
see above

Prerequisites / notice
Supervisor must be a professor at D-ITET or associated, see https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html

Biomedical Engineering MSc

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-1772-10L</td>
<td>Semester Project</td>
<td>Semester Project</td>
<td>8 credits</td>
<td>20A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Registration in mystudies required!

Abstract
The semester project is designed to train the students in solving specific biomedical engineering problems. This project uses the technical and social skills acquired during the master's program. The semester project is advised by a professor.

Objective
see above

D-MAVT (Exchange Students)

Nuclear Engineering MSc

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1009-00L</td>
<td>Master's Thesis Nuclear Engineering</td>
<td>Master's Thesis Nuclear Engineering</td>
<td>30 credits</td>
<td>64D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

Students who fulfill the following criteria are allowed to begin with their Master's Thesis:
- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme;
- c. successful completion of the semester project,
- d. completion of minimum 72 ECTS in the categories "Core Courses" and "Electives" in the Master studies and completion of 8 ECTS in the "Semester Project"

For the supervision of the Master's Thesis, the following professors can be chosen: H.-M. Prasser (ETHZ), M.Q. Tran (EPFL), A. Pautz (EPFL)

Abstract
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

Mechanical Engineering MSc

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1001-00L</td>
<td>Master's Thesis Mechanical Engineering</td>
<td>Master's Thesis Mechanical Engineering</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Students who fulfill the following criteria are allowed to begin with their Master's Thesis:
- a. successful completion of the bachelor program;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme;
- c. successful completion of the semester project and industrial internship;
- d. achievement of 28 ECTS in the category "Core Courses".

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1185 of 1571
Abstract
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

#### Micro- and Nanosystems MSc

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1006-00L</td>
<td>Master's Thesis Micro- and Nanosystems</td>
<td>W</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Students who fulfill the following criteria are allowed to begin with their Master's Thesis:
- a. successful completion of the bachelor program;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme;
- c. successful completion of the semester project;
- d. achievement of 32 ECTS in the category "Core Courses".

The Master's Thesis must be approved in advance by the tutor and is supervised by a professor of ETH Zurich. To choose a titular professor as a supervisor, please contact the D-MAVT Student Administration.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

#### Robotics, Systems and Control MSc

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1016-00L</td>
<td>Master's Thesis Robotics, Systems and Control</td>
<td>W</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Students who fulfill the following criteria are allowed to begin with their Master's Thesis:
- a. successful completion of the bachelor program;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme;
- c. successful completion of the semester project;
- d. achievement of 28 ECTS in the category "Core Courses".

The Master's Thesis must be approved in advance by the tutor and is supervised by a professor of ETH Zurich or an adjunct faculty of RSC. To choose a titular professor as a supervisor, please contact the D-MAVT Student Administration.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

#### Process Engineering MSc

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1005-00L</td>
<td>Master's Thesis Process Engineering</td>
<td>W</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Students who fulfill the following criteria are allowed to begin with their Master's Thesis:
- a. successful completion of the bachelor program;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme;
- c. successful completion of the semester project and industrial internship;
- d. achievement of 28 ECTS in the category "Core Courses".

The Master's Thesis must be approved in advance by the tutor and is supervised by a professor of ETH Zurich. To choose a titular professor as a supervisor, please contact the D-MAVT Student Administration.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

#### D-MTEC (Exchange Students)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0600-00L</td>
<td>Master's Thesis</td>
<td>W</td>
<td>30 credits</td>
<td>57D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:
- a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to
   gain admission to the master programme;
   c. internship fulfilled;
   d. academic writing course has been completed (students
      from Spring Semester 2015 onwards).

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the
tutor and normally deals with a subject contained in the major fields. The research will be performed normally within a private company or
at the ETH Zurich.

Objective
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the
tutor and normally deals with a subject contained in the major fields. The research will be performed normally within a private company or
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Exchange Students - Key for Type

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<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
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</tr>
</thead>
<tbody>
<tr>
<td>V</td>
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<td>lecture with exercise</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Neural Systems and Computation Master

#### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1045-00L</td>
<td>Readings in Neuroinformatics (University of Zurich)</td>
<td>O</td>
<td>3 credits</td>
<td>1S</td>
<td>G. Indiveri, M. Cook, D. Kiper</td>
</tr>
</tbody>
</table>

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

#### Compulsory Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Registration in this class requires the permission of the instructors. Class size will be limited to available lab spots. Preference is given to students that require this class as part of their major.

#### Abstract

Experimental data are always as good as the instrumentation and measurement, but never any better. This course provides the very basics of instrumentation relevant to neurophysiology and neuromorphic engineering. It consists of two parts: a common introductory part involving analog signals and their acquisition (Part I), and a more specialized second part (Part II).

### Objective

The goal of Part I is to provide a general introduction to the signal acquisition process. Students are familiarized with basic lab equipment such as oscilloscopes, function generators, and data acquisition devices. Different electrical signals are generated, visualized, filtered, digitized, and analyzed using Matlab (Mathworks Inc.), or Labview (National Instruments).

In Part II, the students are divided into small groups to work on individual measurement projects according to availability and interest. Students single-handedly solve a measurement task, making use of their basic knowledge acquired in the first part. Various signal sources will be provided.

Prerequisites / notice

For each part, students must hand in a written report and present a live demonstration of their measurement setup to the respective supervisor. The supervisor of Part I is the teaching assistant, and the supervisor of Part II is task specific. Admission to Part II is conditional on completion of Part I (report + live demonstration).

Reports must contain detailed descriptions of the measurement goal, the measurement procedure, and the measurement outcome. Either confidence or significance of measurements must be provided. Acquisition and analysis software must be documented.
ECTS Relevant current papers in neurosciences and neuroinformatics are covered.

Title Systems Neuroscience (University of Zurich)

ECTS 4V, G. Indiveri, S.C. Liu

K. E. Stephan

This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions. Class size will be limited to available lab spots.

Registration in this class requires the permission of the instructors. Class size will be limited to available lab spots. Preference is given to students that require this class as part of their major.

Objective Undertaking computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monographs of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

Content Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monographs of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

Objective To understand the basic concepts underlying perceptual, motor and cognitive functions.

Content Main emphasis sensory systems, with complements on motor and cognitive functions.


Prerequisites / notice none

ECTS 6 credits

Title Methods & Models for fMRI Data Analysis

Lecturers K. A. Martin, M. Cook, V. Mante, M. Pfeiffer

Abstract This course teaches state-of-the-art methods and models for fMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, frequentist and Bayesian inference, multiple comparison corrections, and event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

Objective To obtain in-depth knowledge of the theoretical foundations of SPM and DCM and of their application to empirical fMRI data.

Content This course teaches state-of-the-art methods and models for fMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, frequentist and Bayesian inference, multiple comparison corrections, and event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data. A particular emphasis of the course will be on methodological questions arising in the context of studies in psychiatry, neurology and neuroeconomics.

ECTS 6 credits

Title Neuromorphic Engineering I

Lecturers T. Deibrück, G. Indiveri, S.C. Liu

Abstract This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions. Registration in this class requires the permission of the instructors. Class size will be limited to available lab spots. Preference is given to students that require this class as part of their major.

Objective Understanding of the characteristics of neuromorphic circuit elements.
Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

### Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0151-00L</td>
<td>Linear Algebra</td>
<td>W</td>
<td>4</td>
<td>3G+2U</td>
<td>V. C. Gradinaru, R. Käppeli</td>
</tr>
<tr>
<td>Objective</td>
<td>Einführung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, 5. Auflage 2002</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>401-0603-00L</td>
<td>Stochastics (Probability and Statistics)</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>M. H. Maathuis</td>
</tr>
<tr>
<td>Objective</td>
<td>Knowledge of the basic principles of probability and statistics</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Introduction to probability theory, some basic principles from mathematical statistics and basic methods for applied statistics</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>401-0613-00L</td>
<td>Probability and Statistics</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>J. Teichmann</td>
</tr>
<tr>
<td>Objective</td>
<td>Basic concepts from probability and statistics:</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>a) ability to understand the covered methods from probability theory and to apply them in other contexts</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>b) probabilistic thinking and stochastic modelling</td>
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<td></td>
<td>c) ability to perform basic statistical tests and to interpret the results</td>
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</tr>
<tr>
<td></td>
<td>The conceptual goals are</td>
<td></td>
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<tr>
<td></td>
<td>- the laws of randomness and probabilistic thinking (thinking in probabilities)</td>
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<tr>
<td></td>
<td>- understanding and intuition for stochastic modelling</td>
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<tr>
<td></td>
<td>- simple and basic methods from statistics</td>
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<tr>
<td></td>
<td>The contents of the course encompasses</td>
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</tr>
<tr>
<td></td>
<td>- an introduction to probability theory: basic concepts (probability space, probability measure), independence, random variables, discrete and continuous distributions, conditional probability, expectation and variance, limit theorems</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>- methods from statistics: parameter estimation, maximum likelihood and moment methods, tests, confidence intervals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Lecture notes for the course (in German) will be made available electronically at the beginning of the course.</td>
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227-1044-00L  | Auditory Informatics (University of Zurich) | W    | 2    | 1S    | R. Stoop |
| Abstract     | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: INI413 |
| Prerequisites / notice | Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html |

402-0811-00L  | Programming Techniques for Scientific Simulations I | W    | 5    | 4G    | M. Troyer |
| Abstract     | This lecture provides an overview of programming techniques for scientific simulations. The focus is on advances C++ programming techniques and scientific software libraries. Based on an overview over the hardware components of PCs and supercomputer, optimization methods for scientific simulation codes are explained. |

402-0809-00L  | Introduction to Computational Physics         | W    | 8    | 2V+2U | H. J. Herrmann |
Abstract
This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and supercomputers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions

Content

Prerequisites / notice
Lecture and exercise lessons in English, exams in German or in English

327-0703-00L Electron Microscopy in Material Science

W 4 credits 2V+2U K. Kunze, R. Erni, S. Gerstli, F. Gramm, F. Krumeich

Abstract
A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

Objective
A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

Content
This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, structural geology and structural chemistry will be reported.

Lecture notes
English

Literature

227-0147-00L VLSI II: Design of Very Large Scale Integration

W 7 credits 5G H. Kaeslin, F. K. Gürkaynak, M. Korb

Abstract
This second course in our VLSI series is concerned with how to turn digital circuit netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects. Low-power circuit design is another important topic. Economic aspects and management issues of VLSI projects round off the course.

Objective
Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.

Content
The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI. Topics include:
- The difficulties of finding fabrication defects in large VLSI chips.
- How to make integrated circuit testable (design for test).
- Synchronous clock disciplines compared, clock skew, clock distribution, input/output timing.
- Synchronization and metastability.
- CMOS transistor-level circuits of gates, flip-flops and random access memories.
- Sinks of energy in CMOS circuits.
- Power estimation and low-power design.
- Current research in low-energy computing.
- Layout parasitics, interconnect delay, static timing analysis.
- Switching currents, ground bounce, IR-drop, power distribution.
- Floorplanning, chip assembly, packaging.
- Layout design at the mask level, physical design verification.
- Electromigration, electrostatic discharge, and latch-up.
- Models of industrial cooperation in microelectronics.
- The caveats of virtual components.
- The cost structures of ASIC development and manufacturing.
- Market requirements, decision criteria, and case studies.
- Yield models.
- Avenues to low-volume fabrication.
- Marketing considerations and case studies.
- Management of VLSI projects.

Exercises are concerned with back-end design (floorplanning, placement, routing, clock and power distribution, layout verification). Industrial CAD tools are being used.

Lecture notes

All written documents in English.

Literature

Highlight:
Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.

Prerequisites:
"VLSI I: from Architectures to Very Large Scale Integration Circuits and FPGAs" or equivalent knowledge.

Further details:
http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html

402-0341-00L Medical Physics I

W 6 credits 2V+1U P. Manser

Abstract
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1191 of 1571
The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the excercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

A script will be provided.
Abstract

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes

No lecture notes, but slides will be made available on the course webpage.

Literature


Prerequisites / notice

The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments.
Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

GESS Science in Perspective

see GESS Science in Perspective: Language Courses
ETH/UZH

Recommended GESS Science in Perspective (Type B) for D-ITET

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

Master’s Thesis and Semester Papers/Seminars

Option 1: Long Master’s Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1041-01L</td>
<td>NSC Master’s Theses (long) and Exam (University of Zurich)</td>
<td>W</td>
<td>45 credits</td>
<td>96D</td>
<td>R. Hahnloser</td>
</tr>
</tbody>
</table>

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Only students who fulfill the following criteria are allowed to begin with their master thesis:
a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract

The Master thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

Objective

see above

Option 2: Short Master’s Thesis and Semester Papers/Seminars

Short Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1041-02L</td>
<td>NSC Master’s Thesis and Exam (University of Zurich)</td>
<td>W</td>
<td>29 credits</td>
<td>62D</td>
<td>R. Hahnloser</td>
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</tbody>
</table>

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Only students who fulfill the following criteria are allowed to begin with their master thesis:
a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.
### Abstract

The Master thesis concludes the study programme. Thesis work should prove the students’ ability to independent, structured and scientific working.

### Objective

see above

#### Semester Papers/Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-1036-01L</td>
<td>NSC Master Short Project I (University of Zurich)</td>
<td>W</td>
<td>8 credits</td>
<td>17A</td>
<td>R. Hahnloser</td>
</tr>
<tr>
<td>227-1036-02L</td>
<td>NSC Master Short Project II (University of Zurich)</td>
<td>W</td>
<td>8 credits</td>
<td>17A</td>
<td>R. Hahnloser</td>
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</tbody>
</table>

**Mind the enrolment deadlines at UZH:**
http://www.uzh.ch/studies/application/mobilitaet_en.html

**Abstract**

Usually a student selects the topic of a Master Short Project in consultation with his or her mentor.

**Objective**

see above

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**Neural Systems and Computation Master - Key for Type**

<table>
<thead>
<tr>
<th>O</th>
<th>W+</th>
<th>W</th>
<th>E-</th>
<th>Z</th>
<th>Dr</th>
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<tbody>
<tr>
<td>Compulsory</td>
<td>Eligible for credits and recommended</td>
<td>Eligible for credits</td>
<td>Recommended, not eligible for credits</td>
<td>Courses outside the curriculum</td>
<td>Suitable for doctorate</td>
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</table>

**Key for Hours**

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<th>V</th>
<th>G</th>
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<th>R</th>
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<tbody>
<tr>
<td>lecture</td>
<td>lecture with exercise</td>
<td>exercise</td>
<td>seminar</td>
<td>colloquium</td>
<td>practical/laboratory course</td>
<td>independent project</td>
<td>diploma thesis</td>
<td>revision course / private study</td>
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</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Nuclear Engineering Master

MSc Nuclear Engineering is a joint program of EPFL Lausanne and ETH Zurich. The first semester takes place in Lausanne. Students therefore have to enroll at EPFL.

For more information about the curriculum and courses see: http://master.epfl.ch/cms/site/master/lang/en/nuclearengineering

Core Courses

1. Semester (EPFL)

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-2011-00L</td>
<td>Neutronics (EPFL)</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>external organisers</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at EPFL.</td>
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<tr>
<td>Abstract</td>
<td>In this course, one acquires an understanding of the basic neutronics interactions occurring in a nuclear fission reactor and, as such, the conditions for establishing and controlling a nuclear chain reaction.</td>
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<tr>
<td>Objective</td>
<td>By the end of the course, the student must be able to:</td>
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<tr>
<td></td>
<td>- Elaborate on neutron diffusion equation</td>
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<td></td>
<td>- Systematize nuclear reaction cross sections</td>
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<td></td>
<td>- Formulate approximations to solving the diffusion equation for simple systems</td>
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<td>Content</td>
<td>Content:</td>
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<td></td>
<td>- Brief review of nuclear physics</td>
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<tr>
<td>Literature</td>
<td>Distributed documents, recommended book chapters</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisite for: Reactor Experiments</td>
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</table>

151-2013-00L | Reactor Experiments (EPFL) | O | 4 credits | 5U | external organisers |
|             | No enrolment to this course at ETH Zurich. Book the corresponding module directly at EPFL. |
| Abstract    | To gain hands-on experience in the conduction of nuclear radiation measurements, as also in the execution and analysis of reactor physics experiments using the CROCUS reactor. |
| Objective   | To gain hands-on experience in the conduction of nuclear radiation measurements, as also in the execution and analysis of reactor physics experiments using the CROCUS reactor. |
| Content     | - Radiation detector systems, alpha and beta particles |
|             | - Radiation detector systems, gamma spectroscopy |
|             | - Introduction to neutron detectors (He-3, BF3) |
|             | - Slowing-down area (Fermi age) of Pu-Be neutrons in H2O |
|             | - Approach-to-critical experiments |
|             | - Buckling measurements |
|             | - Reactor power calibration |
|             | - Control rod calibration |
| Literature  | Distributed documents, recommended book chapters |
| Prerequisites / notice | Prerequisite for: Special Topics in Reactor Physics (2nd sem.) |

151-2015-00L | Reactor Technology (EPFL) | O | 4 credits | 3G | H.M. Prasser, external organisers |
|             | No enrolment to this course at ETH Zurich. Book the corresponding module directly at EPFL. |
| Abstract    | This course provides an overview of microfabrication processes used to produce micro-scale robots and will cover topics related to microactuators, microsensors, and modeling at these scales. The course will also investigate micromanipulation technologies, incl. the assembly of micron-sized parts, the manipulation of biological cells, and the types of robots used to perform these tasks. |
| Objective   | To comprehend (particularly in the context of light water reactors) the basic heat removal phenomena in a reactor core, identify the technological limits for heat generation from the viewpoints of fuel, cladding and coolant, and be introduced to optimization principles in reactor thermal design. |
### Content

- Fuel rod, LWR fuel elements
- Temperature field in fuel rod
- Reactor core, design
- Flux and heat source distribution, cooling channel
- Single-phase convective heat transfer, axial temperature profiles
- Boiling crisis and DNB ratio
- Pressurized water reactors, design
- Primary circuit design
- Steam generator heat transfer, steam generator types
- Boiling water reactors
- Reactor design
- LWR power plant technology
- Other types of reactors (overview)
- Generation IV systems

### Literature

Distributed documents, recommended book chapters

### Prerequisites / notice

Required prior knowledge: Neutronics
Prerequisite for: Nuclear Safety (2nd sem.)

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### 151-2043-00L Radiation Protection and Radiation Applications (EPFL)

**Abstract**

An introductory course in the basic concepts of radiation detection and interactions and energy deposition by ionizing radiation in matter, radionuclide production and its applications in medicine, industry and research. The course includes presentations, lecture notes, problem sets and seminars.

**Objective**

By the end of the course, the student must be able to:

- Explain the basic physics principles that underpin radiotherapy, e.g. types of radiation, atomic structure, etc.
- Explain the interaction mechanisms of ionizing radiation at keV and MeV energies with matter.
- Explain the principles of radiation dosimetry.
- Describe how to use radiotherapy equipment both for tumour localisation, planning and treatment.
- Define quality assurance and quality control, in the context of radiotherapy and the legal requirements.
- Explain the principles and practice of radiation protection, dose limits, screening and protection mechanisms.
- Explain the use of radiation in industrial and research applications.

**Content**

Basics: radiation sources and interaction with matter, radionuclide production using reactors and accelerators, radiation protection and shielding.

Medical applications: diagnostic tools, radionuclide production using reactors and accelerators, radiation protection and shielding.

- Therapeutic radiation physics including X-rays, electron beam physics, radioactive sources, use of unsealed sources and Brachytherapy.
- Describe how to use radiotherapy equipment both for tumour localisation, planning and treatment.
- Define quality assurance and quality control, in the context of radiotherapy and the legal requirements.
- Explain the principles and practice of radiation protection, dose limits, screening and protection mechanisms.
- Explain the use of radiation in industrial and research applications.

---


**Abstract**

To understand the basic principles governing the advanced energy conversion systems and the perspective for technological progress. To present the essential characteristics of the main fossil and renewable energy systems from a resource and production technology viewpoint. Learning to assess the globally and locally available resources of such energies and be able to make a rough dimensioning of the installations that will use them.

**Objective**

To understand the basic principles governing the advanced energy conversion systems and the perspective for technological progress. To present the essential characteristics of the main fossil and renewable energy systems from a resource and production technology viewpoint. The students will learn to assess the globally and locally available resources of such fossil or renewable energies and be able to make a rough dimensioning of the installations that will use them.

**Content**

- Overview of fossil and renewable energy resource characteristics
- Reminder of Thermodynamic Laws and exergy theory
- Vapour and gas cycles, combined cycles. Natural gas, coal and nuclear power plants
- Fuel cell principles and technologies. Hybrid fuel cell - turbine cycles
- Technologies of heat pumps (compression, absorption, magnetic) and Organic Rankine Cycles (ORC). Co- and tri-generation
- Biomass technologies for both fuel (liquid or gas) or electricity
- Solar energy resources
- Solar-thermal and photovoltaic systems
- Hydraulic resources
- Hydraulic turbines and schemes
- Wind energy resources
- Wind turbines
- Other renewable technologies

**Literature**

Bibliographie: Notes of the lectures; Borel, Favrat Thermodynamique et énergétique PPUR 2005, Haldi et al. Systèmes énergétiques PPUR 2003 (distributed course notes and partial translation of chapters of books)

**Prerequisites / notice**

Required prior knowledge: Basic knowledge of physics and thermodynamics

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### 151-2021-00L Hydraulic Turbomachines (EPFL)

**Abstract**

No enrolment to this course at ETH Zurich. Book the corresponding module directly at EPFL.

**Objective**

To understand the basic principles governing the advanced energy conversion systems and the perspective for technological progress. To present the essential characteristics of the main fossil and renewable energy systems from a resource and production technology viewpoint. The students will learn to assess the globally and locally available resources of such fossil or renewable energies and be able to make a rough dimensioning of the installations that will use them.

**Content**

- Overview of fossil and renewable energy resource characteristics
- Reminder of Thermodynamic Laws and exergy theory
- Vapour and gas cycles, combined cycles. Natural gas, coal and nuclear power plants
- Fuel cell principles and technologies. Hybrid fuel cell - turbine cycles
- Technologies of heat pumps (compression, absorption, magnetic) and Organic Rankine Cycles (ORC). Co- and tri-generation
- Biomass technologies for both fuel (liquid or gas) or electricity
- Solar energy resources
- Solar-thermal and photovoltaic systems
- Hydraulic resources
- Hydraulic turbines and schemes
- Wind energy resources
- Wind turbines
- Other renewable technologies

**Literature**

Bibliographie: Notes of the lectures; Borel, Favrat Thermodynamique et énergétique PPUR 2005, Haldi et al. Systèmes énergétiques PPUR 2003 (distributed course notes and partial translation of chapters of books)

**Prerequisites / notice**

Required prior knowledge: Basic knowledge of physics and thermodynamics
corresponding module directly at EPFL.

Abstract
Mastering the scientific design of a hydraulic machine, pump and turbine, by using the most advanced engineering design tools. For each chapters the theoretical basis are first established and then practical solutions are discussed with the help of recent design examples.

Objective
Mastering the scientific design of a hydraulic machine, pump and turbine, by using the most advanced engineering design tools. For each chapters the theoretical basis are first established and then practical solutions are discussed with the help of recent design examples.

Content
- Turbomachine equations, mechanical power balance in a hydraulic machines, moment of momentum balance applied to the runner/impeller, generalized Euler equation.
- Hydraulic characteristic of a reaction turbine, a Pelton turbine and a pump, losses and efficiencies of a turbomachine, real hydraulic characteristics.
- Similitude laws, non dimensional coefficients, reduced scale model testing, scale effects.
- Cavitation, hydraulic machine setting, operating range, adaptation to the piping system, operating stability, start stop transient operation, runaway.
- Reaction turbine design: general procedure, general project layout, design of a Francis runner, design of the spiral casing and the distributor, draft tube role, CFD validation of the design, design fix, reduced scale model experimental validation.
- Pelton turbine design: general procedure, project layout, injector design, bucket design, mechanical problems.
- Centrifugal pump design: general architecture, energetic loss model in the diffuser and/or the volute, volute design, operating stability.

Literature
Notes de cours polycopiées et littérature spécialisée (IMHEF, industrie, associations scientifiques, congrès, etc.).

Prerequisites / notice
Prérequis: Mécanique des milieux continus; Introduction aux turbomachines.
Préparation pour: Chois des équipements hydrauliques; Projets et travail pratique de Master
This course covers the physical principles underlying medical imaging using ionizing radiation (radiography, fluoroscopy, CT, SPECT, PET). The focus is not only on risk and close to the patient and staff, but also on an objective description of the image quality.

### Content
- Physics of radiography: X-ray production, Radiation-patient interaction, Image detection and display
- Image quality: Wagner's taxonomy, MTF, NPS, contrast, SNR, DQE, NEQ, CNR
- Dose to the patient: External irradiation, Internal contamination, compartmental models
- Physics of computer tomography (CT)
- Risk and radiation: Rational risk and state of our knowledge, Psychological aspects, Ethics and communication
- Physics of single-photon emission computed tomography (SPECT)
- Physics of mammography
- Receiver operating characteristics (ROC) and hypothesis testing: Link between medical diagnostic and statistical hypothesis testing, Sensitivity, specificity, prevalence, predictive values
- Physics of radioscopy
- Model observers in medical imaging: Human visual characteristics and their quantification, Bayesian cost and Ideal model observer, Anthropomorphic model observers, Detection experiments (rating, M-AFC, yes-no)
- Physics of positron emission tomography (PET)
- Physics of resonance magnetic imaging

### Objective

**Abstract**

To acquire hands-on experience with the running of large computer codes in relation to the static analysis of nuclear reactor cores and the multi-physics simulation of nuclear power plant (NPP) dynamic behaviour.

**Content**

- Lattice (assembly) calculations
- Thermal-hydraulic analysis
- Reactor core analysis
- Multi-physics core dynamics calculations
- Best-estimate NPP transient analysis

**Literature**

Distributed documents, recommended book chapters

**Prerequisites / notice**

Required prior knowledge: Special Topics in Reactor Physics, Nuclear Safety

---

**3. Semester (PSI)**

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
151-2037-00L | Nuclear Computations Lab | O | 3 credits | 3G | A. Pautz, H. Ferroukhi, further lecturers

**Abstract**

Students registered at ETH Zurich have to enroll to this course at ETH. EPFL students can enroll to this course directly at EPFL.

**Content**

- Lattice (assembly) calculations
- Thermal-hydraulic analysis
- Reactor core analysis
- Multi-physics core dynamics calculations
- Best-estimate NPP transient analysis

**Prerequisites / notice**

Students registered at ETH Zurich have to enroll to this course at ETH. EPFL students can enroll to this course directly at EPFL.

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
151-2039-00L | Beyond-Design-Basis Safety | O | 3 credits | 2V | H.M. Prasser, L. Fernandez Moguel, B. Jäckel, T. Lind, D. Paladino

**Abstract**

Students registered at ETH Zurich have to enroll to this course at ETH. EPFL students can enroll to this course directly at EPFL.

**Content**

To acquire hands-on experience with the running of large computer codes in relation to the static analysis of nuclear reactor cores and the multi-physics simulation of nuclear power plant (NPP) dynamic behaviour.

**Prerequisites / notice**

Prerequisites: Recommended courses: 151-0156-00L Safety of Nuclear Power Plants plus either 151-0163-00L Nuclear Energy Conversion or 151-2015-00L Reactor Technology

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**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
151-2045-00L | Decommissioning of Nuclear Power Plants | O | 4 credits | 3G | A. Pautz, M. Brandauer, F. Leibundgut, M. Pantelias García, H.M. Prasser

**Abstract**

Students registered at ETH Zurich have to enroll to this course at ETH. EPFL students can enroll to this course directly at EPFL.

**Content**

Introduction to aspects of Nuclear Power Plant decommissioning including project planning and management, costs and financing, radiological characterization, dismantling/decontamination technologies, safety aspects and radioactive waste management considerations.

**Objective**

Aim of this course is to provide the students with an overview of the multidisciplinary issues that have to be addressed for the successful decommissioning of NPPs. Students will get exposed to principles of project management, operations management, managerial accounting, radiological characterization, technologies relevant to the safe dismantling of NPPs and best-practice in the context of radioactive waste management.
The main objective of the 12-week internship is to expose master's students to the industrial work environment within the field of nuclear Uncertainty Quantification for Engineering & Life.

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature.

Lecturers

P. Koumoutsakos

Title

Slides will be handed out.

17A

Industrial Internship Nuclear Engineering

external organisers

The main objective of the 12-week internship is to expose master's students to the industrial work environment within the field of nuclear energy. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective

The main objective of the 12-week internship is to expose master's students to the industrial work environment within the field of nuclear energy.

Prerequisites / notice

The internship must be approved by the tutor.

> Electives

Course from the catalogue of Master courses ETH Zurich and EPFL. At least 4 credit points must be collected from the offer of Science in Perspective (SiP) compulsory electives at ETH Zurich or Management of Technology and Entrepreneurship at EPFL.

> Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1021-00L</td>
<td>Industrial Internship Nuclear Engineering Only for Nuclear Engineering MSc.</td>
<td>O</td>
<td>8</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

Abstract

The main objective of the 12-week internship is to expose master's students to the industrial work environment within the field of nuclear energy. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective

The main objective of the 12-week internship is to expose master's students to the industrial work environment within the field of nuclear energy.

Prerequisites / notice

The internship must be approved by the tutor.

> Semester Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1020-00L</td>
<td>Semester Project Nuclear Engineering Only for Nuclear Engineering MSc.</td>
<td>O</td>
<td>8</td>
<td>17A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract

The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

Objective

The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's programme.

> Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1009-00L</td>
<td>Master's Thesis Nuclear Engineering Students who fulfill the following criteria are allowed to begin with their Master's Thesis:</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

Students who fulfill the following criteria are allowed to begin with their Master's Thesis:

- Legal framework, project management and operations methods and tools, cost estimation approaches and methods, nuclear calculations and on-site radiological characterization and inventorying, state-of-the-art technologies for decontamination and dismantling, safety considerations, state-of-the-art practice for radioactive waste treatment, packaging and transport, interface with radioactive waste management and disposal. The course will additionally include student visits to relevant nuclear sites in Switzerland and Germany.

- The course deals with the important challenges for materials (structural and fuel) for current and advanced nuclear power plants. Experimental techniques and tools used for working with active materials are discussed in detail. Students will be well acquainted with analytical and modeling methodologies for damage assessment and residual life determination and with the behavior of high burnup fuel.

- The behaviour of materials in nuclear reactors determines the reliability and safety of nuclear power plants (NPPs). Life extension and the understanding of fuel behavior under high burn-up conditions is of central importance for current-day NPPs. Advanced future systems (fission and fusion) need materials meeting additional challenges such as high temperatures and or high doses.

- The course will highlight the above needs from different points of view. Experimental methods for the control and analysis of nuclear components and materials in operating NPPs will be presented. Advanced analytical and modeling tools will be introduced for characterization and understanding of irradiation damage, creep, environment effects, etc. Insights acquired from recent experimental programs into high burnup fuel behavior under hypothetical accident conditions (RIA, LOCA) will be presented. Materials for advanced future nuclear plants will be discussed.

- The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

- The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's programme.

- Students who fulfill the following criteria are allowed to begin with their Master's Thesis:

- The main objective of the 12-week internship is to expose master's students to the industrial work environment within the field of nuclear energy. During this period, students have the opportunity to be involved in on-going projects at the host institution.

- The main objective of the 12-week internship is to expose master's students to the industrial work environment within the field of nuclear energy.

- The internship must be approved by the tutor.
a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to
gain admission to the master programme.
c. successful completion of the semester project.
d. completion of minimum 72 ECTS in the categories
"Core Courses" and "Electives" in the Master studies and
completion of 8 ECTS in the "Semester Project"

For the supervision of the Master's Thesis, the following
professors can be chosen: H.-M. Prasser (ETHZ), M.Q.
Tran (EPFL), A. Pautz (EPFL)

Abstract
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently
toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are
proposed by the tutor and further elaborated with the student.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

---

**Nuclear Engineering Master - Key for Type**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

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**Key for Hours**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

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**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**
First identification with Pharmaceutical Sciences; motivation for profiling in the Natural Sciences, which are focused on within the first two years as a preparation for the specialized studies; sensitization for the duties and the responsibilities of a person with a federal diploma in Pharmacy; information about job opportunities.

**Objective**
First identification with Pharmaceutical Sciences; motivation for profiling in the Natural Sciences as a preparation for the specialized studies; sensitization for the duties and the responsibilities of a person with a federal diploma in Pharmacy; information about job opportunities.

**Content**
Introduction to Pharmaceutical Sciences by selected milestones of research and development. Overview on research activities at the Institute of Pharmaceutical Sciences that is focussed on drug delivery and development (from concepts to prototypes). Sensitization for communication skills and information management. Demonstration of job opportunities in community pharmacies, in the hospital, in industry, and in the public sector by experts in the different fields.

**Lecture notes**
Handouts for individual lectures.

**Prerequisites / notice**
Interactive teaching

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0291-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6</td>
<td>4V+2U</td>
<td>E. W. Farkas</td>
</tr>
</tbody>
</table>

**Abstract**
Mathematics I/II is an introduction to one- and multidimensional calculus and linear algebra emphasizing on applications.

**Objective**
Students understand mathematics as a language for modeling and as a tool for solving practical problems in natural sciences.
Students can analyze models, describe solutions qualitatively or calculate them explicitly if need be. They can solve examples as well as their practical applications manually and using computer algebra systems.

**Content**
Einführung in die Differential- und Integralrechnung von Funktionen einer Variablen und Anwendungen:

**Literature**
Siehe Lernmaterialien > Literatur
L. Papula, Mathematik für Ingenieure und Naturwissenschaftler, 11. Auflage, Vieweg und Teubner
Th. Wihler, Mathematik für Naturwissenschaften, 2 Bände: Einführung in die Analysis, Einführung in die Lineare Algebra; Haupt-Verlag Bern, UTB
Ch. Blatter, Lineare Algebra; VDF
H. H. Storrer: Einführung in die mathematische Behandlung der Naturwissenschaften I; Birkhäuser.

**Prerequisites / notice**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0852-00L</td>
<td>Foundations of Computer Science</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>L. E. Fässler, H.J. Böckenhauer, M. Dahinden, D. Komm, H. Lehner</td>
</tr>
</tbody>
</table>

**Abstract**
Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects.

The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.

**Objective**
The students learn to:
- understand the role of computer science in science,
- control computer and automate processes of problem solving by programming,
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

**Content**
1. The role of computer science in science
2. Introduction to Programming with Python
3. Modeling and simulations
4. Introduction to Matrices with Matlab
5. Visualizing multidimensional data
6. Data management with lists and tables
7. Data management with a relational database
8. Universal methods for algorithm design

**Lecture notes**
All materials for the lecture are available at www.gdi.ethz.ch

**Prerequisites / notice**
This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-1001-01L</td>
<td>General Chemistry (for Biology/Pharmacy/HST)</td>
<td>O</td>
<td>4</td>
<td>4V</td>
<td>W. Uhlig</td>
</tr>
</tbody>
</table>

**Abstract**
This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

**Objective**
This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

**Content**
This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

**Lecture notes**
All materials for the lecture are available at www.gdi.ethz.ch

**Prerequisites / notice**
This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.
The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

The course is designed to provide an understanding of the basic principles and concepts of general and inorganic chemistry. The course is divided into several chapters:

- M. Aebi

ECTS

None.

The course provides an introduction to the basics of molecular- and cell biology and genetics. The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions; properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

The course consists of plenary lectures (2 h per week) and problem-solving lessons (2 h per week, groups of ca. 25 people). In addition, online exercises are available in the e-learning environment Moodle (Course OC I).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0657-00L</td>
<td>Communication and Social Competences</td>
<td>O</td>
<td>1</td>
<td>1V</td>
<td>J. Stadelwieser</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction into basic skills of rhetoric, presentation, communication. Introduction into learning and working techniques and writing protocols.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Students . . .</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>(1) recognize the importance of effective communication/presentation regarding objectives and audience; (2) know the basics of rhetoric, communication, presentation, learning and working techniques; (3) are enabled to prepare presentations (with slides/powerpoint); (4) know four types of protocols; (5) are enabled to write protocols; (6) know possibilities to optimize their learning and working success; (7) are enabled to scrutinize a scientific text.</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>no script; handout and working papers.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-1011-00L</td>
<td>Organic Chemistry I (for students of Biology, Pharmaceutical Sci., and Health Sci. &amp; Tech.)</td>
<td>O</td>
<td>4</td>
<td>4G</td>
<td>C. Thilgen</td>
</tr>
<tr>
<td>Abstract</td>
<td>Fundamentals of Organic Chemistry: molecular structure. Bonding and functional groups; nomenclature; resonance and aromaticity; stereochemistry; conformation; bond strength; organic acids and bases; basic reaction thermodynamics and kinetics; reactive intermediates: carbanions, carbocations and radicals.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Understanding the basic concepts and definitions of organic chemistry. Knowledge of the functional groups and classes of compounds that are important in biological systems. Foundations for the understanding of the relationship between structure and reactivity.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Printed lecture notes are available. Exercises, answer keys and other handouts can be downloaded from the Moodle course &quot;Organic Chemistry I&quot; of the current semester (<a href="https://moodle-app2.let.ethz.ch">https://moodle-app2.let.ethz.ch</a>). Lecture notes are available.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>None.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The text-book &quot;Biology&quot; (Campbell, Reece) (10th edition) is the basis of the course. The structure of the course is largely identical with that of the text-book.</td>
<td></td>
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</tbody>
</table>

**Additional First Year Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-1001-00L</td>
<td>Laboratory Course General Chemistry (for Biology and Pharmacy)</td>
<td>O</td>
<td>6</td>
<td>8P</td>
<td>R. O. Kassner, K.H. Altmann, J. Hall, D. Neri, G. Schneider, M. D. Wörle</td>
</tr>
<tr>
<td>Abstract</td>
<td>Information about the practical course will be given on the first day.</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
Introduction to the practical work in a chemistry laboratory. The most important manipulations and techniques are treated, as well as the the most fundamental chemical reaction types.

**Objective**
- Knowledge of the basic chemical laboratory methods.
- Basic knowledge of the scientific approach in experimenting.
- Observation and interpretation of real-world chemical processes.
- Keeping of a reliable laboratory journal.

**Content**
- Simple chemical methods and calculations.
- Separation techniques.
- Physical measurements: mass, volume, pH, optical spectra.
- Ionic solids (salts).
- Acid/base chemistry, buffers.
- Redox reactions.
- Metal complexes.
- Titration methods and quantitative spectrometry.
- Introduction to qualitative analysis.

**Lecture notes**
Course manual in German (is handed out to the students at the begin of the lessons).
Language: German, English upon request.

PDF files available at http://aac1.ethz.ch/praktikum/docs.html

**Literature**

This practical course causes costs for materials and chemicals. The costs are charged to the students at the end of semester.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1042-00L</td>
<td>Analytics</td>
<td>O</td>
<td>2</td>
<td>1.5G</td>
<td>M. Badertscher</td>
</tr>
<tr>
<td></td>
<td>Principles of the most important separation techniques and the interpretation of molecular spectra. Knowledge of the necessary basics and the possibilities of application of the relevant spectroscopical and separation methods in analytical chemistry.</td>
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<tr>
<td></td>
<td>A comprehensive script is available in the HCI-Shop. A summary of the part &quot;Spektroskopie&quot; defines the relevant material for the exam.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Pretsch E., Bühmann P., Badertscher M., Spektroskopische Daten zur Strukturaufklärung organischer Verbindungen, fünfte Auflage, Springer-Verlag, Berlin 2010;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- K. Cammann, Instrumentelle Analytische Chemie, Verfahren, Anwendungen, Qualitätssicherung, Spektrum Akademischer Verlag, Heidelberg, 2001;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>535-0223-00L</td>
<td>Pharmaceutical Analytics I</td>
<td>O</td>
<td>1</td>
<td>1.5G</td>
<td>C. Steuer</td>
</tr>
<tr>
<td></td>
<td>Theoretical and practical comprehension of analytical chemistry in order to solve pharmaceutical problems.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Knowledge in Pharmaceutical Analytics in order to solve fundamental analytical problems. Handling of the most important pharmacoepial texts and monographs.</td>
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</tr>
<tr>
<td></td>
<td>Introduction in Pharmaceutical Analytics. Theoretical and practical considerations concerning a lot of methods in different Pharmacoepias.</td>
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</tr>
<tr>
<td></td>
<td>The script can be downloaded from the IPW homepage, &quot;course materials&quot;.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>535-0223-00L</td>
<td>Pharmaceutical Analytics I</td>
<td>O</td>
<td>1</td>
<td>1.5G</td>
<td>C. Steuer</td>
</tr>
<tr>
<td></td>
<td>Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.</td>
<td></td>
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</tbody>
</table>

**Prerequisites / notice**
- 529-1001-01 V "Allgemeine Chemie I (für Biol./Pharm.Wiss.)"
- 535-1001-00 P "Allgemeine Chemie I (für Biol./Pharm.Wiss.)"
- 529-1011-00 G "Organische Chemie I (für Biol./Pharm.Wiss.)"

**Prerequisites / notice**
- Introduction to qualitative analysis.
- Titration methods and quantitative spectrometry.
- Metal complexes.
- Physical measurements: mass, volume, pH, optical spectra.
- Ionic solids (salts).
- Acid/base chemistry, buffers.
- Redox reactions.
- Simple chemical methods and calculations.

**Abstract**
The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

**Objective**
The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

**Content**
The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

**Lecture notes**
The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the nethz (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.

**Literature**

**Prerequisites / notice**
Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.
Anatomy and Physiology I
K. Locher

Lecturers

Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycans, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.

Prerequisites / notice

Some of the lectures are given in the English language.

Prerequisites:

Basic knowledge of human anatomy and physiology and basics of clinical pathophysiology.

Literature


Objective

Understanding the fundamental thermodynamical properties of chemical and biological systems.

Content

Activity, thermodynamical tables, Chemical potential, thermodynamical parameters of reaction, equilibrium conditions and their temperature and pressure dependence, biochemical reactions, surface effects, colligative properties.

Lecture notes

in process, will be distributed at the beginning of the first lecture

Literature


Prerequisites / notice

Prerequisite: mathematics I-II, functions of multiple variables, partial derivatives.

376-0151-00L Anatomy and Physiology I

Number

O 5 credits 4V

Prerequisites:

Basic knowledge of the anatomy and physiology of tissues, of the embryonal and postnatal development, of the basic terminology of pathology, the neuro-muscular system, the cardiovascular system and the respiratory system.

Abstract

Basic knowledge of human anatomy and physiology and basics of clinical pathophysiology.

Content

Anatomy and Physiology I (fall term): Basics of cytology, histology, embryology, general pathology; nervous system, muscles, cardiovascular system, respiratory system

Anatomy and Physiology II (spring term): digestive system, kidney and urinary tract, endocrine system, skin, thermoregulation, sensory organs, male and female reproductive system, pregnancy and child birth.

Literature


Physiologie:


Prerequisites / notice

Voraussetzungen: 1. Jahr, naturwissenschaftlicher Teil
### Third Year Core Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0230-00L</td>
<td>Medicinal Chemistry I</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>J. Hall</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The lectures give an overview of selected drugs and the molecular mechanisms underlying their therapeutic effects in disease. The historical and modern-day methods by which these drugs were discovered and developed are described. Structure-function relationships and the biophysical rules underlying ligand-target interactions will be discussed and illustrated with examples.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Basic understanding of therapeutic agents with respect to molecular, pharmacological and pharmaceutical properties.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Molecular mechanisms of action of drugs. Structure function and biophysical basis of ligand-target interactions</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Will be provided in parts before each individual lecture.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Requirements: Knowledge of physical and organic chemistry, biochemistry and biology. Attendance of Medicinal Chemistry II in the spring semester.</td>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>535-0421-00L</td>
<td>Galenic Pharmacy I</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>J.C. Leroux, B. A. Gander</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Principles and technologies for the manufacturing of dosage forms and drug delivery systems. Knowledge of pharm. excipients, materials, containers, liquid and semi-solid dosage forms, their production, function, quality and application. Comprehension of molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in dosage forms.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Knowledge of the most important pharmaceutical excipients, materials, containers, liquid and semi-solid dosage forms, their production, function, quality, stability and application. Comprehension of the molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in disperse dosage forms.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Introduction and overview of important fundamentals, principles and technologies for the development and manufacturing of dosage forms and drug delivery systems. Overview of the most important pharmaceutical excipients and polymers, their structure, properties and processing; importance of materials properties for containers. Pharmaceutical solvents, fundamentals of solubility and solubilization of drugs. Water treatment processes, sterilization techniques and quality requirements of pharmaceutical water. Parenteral dosage forms and liquid ophthalmics. Surfactants, micelles formation and colloidal systems. Liquid suspensions and emulsions. Stabilization measures in dosage forms.</td>
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</tbody>
</table>
| **Literature** | C.-D. Herzfeldt und J. Kreuter (Hrsg.) Grundlagen der Arzneiformenlehre, Springer Verlag, Berlin 1999  
H. Leuenberger (Hrsg.) Martin - Physikalische Pharmazie, Wissenschaftliche Verlagsgesellschaft, Stuttgart 2002  
R. Voigt, Pharmazeutische Technologie, 10. Auflage, Deutscher Apotheker Verlag, Stuttgart, 2006  
| **Prerequisites / notice** | Language: German and English |

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>535-0521-00L</td>
<td>Pharmacology and Toxicology I</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>U. Quitterer</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The two-semester lecture course will provide a detailed understanding of the fundamentals of drug action and the mechanisms of action and therapeutic use of the important classes of drugs. The lectures are intended for students of pharmaceutical sciences.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Topics include disease-relevant macroscopic, microscopic, pathobiochemical and functional disturbances of specific organs and organ systems. The lectures integrate disease pathology with mechanisms of drug action, usage, metabolism, pharmacoekinetics, side effects, toxicology, contraindactions and dosage of relevant drug classes. Basic principles of clinical pharmacology and pharmacotherapy will be covered.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The lectures will provide a comprehensive survey of pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Für jede Vorlesung wird ein Skript abgegeben, das eine Zusammenfassung mit den wichtigsten Stichpunkten beinhaltet. Die Skripte enthalten die Hauptpunkte der Vorlesung und definieren prüfungsrelevante Kenntnisse. Sie ersetzen die Vorlesung nicht!</td>
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</table>
Literature

Recommended reading:

Klaus Aktories, Ulrich Förstermann, Franz Hofmann, Klaus Starke.
Allgemeine und spezielle Pharmakologie und Toxikologie.
11. überarb. Auflage - 1216 Seiten
2013; Urban & Fischer bei Elsevier, München

or

Heinz Lüllmann, Klaus Mohr, Lutz Hein, Martin Wehling
Pharmakologie und Toxikologie.
Arzneimittelwirkungen verstehen - Medikamente gezielt einsetzen
18. Auflage - 740 Seiten

Comprehensive overview:

Heinz Lüllmann, Klaus Mohr, Lutz Hein.
Taschenatlas der Pharmakologie.
7. Auflage - 424 Seiten

The classic textbook in Pharmacology:

Goodman and Gilman`s The Pharmacological Basis of Therapeutics
Laurence Brunton, Bruce Chabner, Bjorn Knollman.
12th edition - 1808 Seiten

Prerequisites / notice

Voraussetzungen: Abschluss Grundstudium

535-0333-00L Pharmaceutical Biology O 3 credits 3V K.H. Altmann

Abstract
The structure and biosynthesis of plant constituents and the pharmacological effects and therapeutic applications of biogenic drugs of plant origin (extract-based herbal medicines; isolated natural products) are discussed. Areas of focus are (a) major biosynthetic pathways for plant-derived natural products, (b) pharmacological effects of herbal extracts, and (c) molecular mechanisms of action.

Objective
The understanding of the biosynthesis of plant-derived natural products. Acquisition of fundamental knowledge on the medical applications of important herbal medicines and of isolated natural products (general disease areas, molecular constituents of medicinal plants and herbal medicines in general, molecular constituents responsible for pharmacological activity, possible mechanisms of action, available clinical data to support medical use).

Content
The lecture is centered around the discussion of medicinal plants and herbal medicines and their common medical applications. The main areas addressed in the lecture are (a) the structure and biosynthesis of plant constituents (i.e. plant-derived natural products) and (b) the pharmacological effects and therapeutic applications of biogenic drugs of plant origin (herbal medicines based on plant extracts as well as isolated natural products). The basic pathways for the biosynthesis of the most important classes of plant-derived natural products are discussed in detail. Likewise, the molecular basis of the pharmacological effects of medicinal plant extracts (and derived herbal medicines) and their individual constituent components (isolated natural products) is broadly addressed. As part of this discussion the availability of clinical data (or lack thereof) to support specific clinical applications of herbal medicines will be repeatedly highlighted. Potential risks associated with the use of herbal medicines are discussed for selected cases.

The lecture is structured according to the major classes of natural products prevalent in medicinal plants and herbal medicines: Carbohydrates, lipids, terpenes, phenolic compounds, alkaloids, essential oils.

Lecture notes
Is provided in parts before each lecture (electronically as pdf) and also available on the Ilias platform via My Studies.

535-0810-00L Gene Technology O 2 credits 2G D. Neri

Abstract
The course will provide a solid overview of the science and issues in gene technology and its pharmaceutical applications.

The aim of the lecture course is to provide a solid overview of gene technology, with a special focus on drug development. Topics: Antibody phage technology, DNA-encoded chemistry, protein modification technology, genome sequencing, transcriptomics, proteomics, functional genomics, principle of drug discovery. The course is suited for advanced undergraduate and early graduate students in pharmaceutical sciences or related fields.

Prerequisites / notice
Requirements: Lecture courses in organic chemistry, biochemistry, and biology
1. Antibody phage technology
   - The antibody molecule
   - V genes, CDRs, basics of antibody engineering
   - Principles of phage display
   - Phagemid and phage vectors
   - Antibody libraries
   - Phage display selection methodologies
   - Other phage libraries (peptides, globular proteins, enzymes)
   - Alternative screening/selection methodologies
   - DNA-encoded chemical libraries

2. Proteins: chemical modification and detection of biomolecular interactions
   - Homo- and hetero-dimerization of proteins
   - Chemical modifications of proteins
   - Antibody-drug conjugates
   - Radioactive labeling of proteins
   - Kinetic association and dissociation constants
   - Affinity constant: definition and its experimental measurement

3. Genomics: Applications to Human Biology
   - Protein cloning and expression
   - DNA sequencing
   - Some foundations of genetic analysis
   - Knock-out technologies
   - Transcriptomics
   - Proteomics
   - Recombinant vaccines

4: Pharmaceuticals: Focus on Discovery
   - Ligand Discovery
   - Half-life extension
   - Cancer therapy
   - Gene therapy

Lecture notes
   - Skript "Gene Technology" by Prof. Dario Neri and slides of the lecture

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
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<th>Credits</th>
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<th>Lecturer(s)</th>
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<tbody>
<tr>
<td>535-0830-00L</td>
<td>Pharmaceutical Immunology</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>D. Neri, C. Halin Winter</td>
</tr>
<tr>
<td>Abstract</td>
<td>Get Students familiar with basic Immunological concepts of pharmaceutical relevance.</td>
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<tr>
<td>Objective</td>
<td>Get Students familiar with basic Immunological concepts of pharmaceutical relevance.</td>
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<tr>
<td>Content</td>
<td>Chapters 1 - 11 of the Janeway's ImmunoBiology, by Kenneth Murphy (9th Edition; Garland).</td>
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<tr>
<td>Literature</td>
<td>Janeway's ImmunoBiology, by Kenneth Murphy (9th Edition).</td>
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<tr>
<td>Lecture notes</td>
<td>&quot;Gene Technology&quot; by Prof. Dario Neri and slides of the lecture</td>
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<tbody>
<tr>
<td>535-0210-00L</td>
<td>Radiopharmaceutical Chemistry</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>R. Schibli, S. M. Ametamey</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction of basic principles of radiation, structure and function of radiopharmaceuticals, examples of radiopharmaceuticals in nuclear medicine practice, discussion of functional radiopharmaceuticals, molecular imaging, targeted radionuclide therapy, radiopharmaceutical synthesis.</td>
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<tr>
<td>Objective</td>
<td>Introduction of basic principle of radiation, structure and function of radiopharmaceuticals, examples of radiopharmaceuticals in nuclear medicine practice, discussion of functional radiopharmaceuticals, molecular imaging, targeted radionuclide therapy, radiopharmaceutical synthesis.</td>
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<tr>
<td>Content</td>
<td>Introduction radioactivity, radiopharmaceuticals, PET- and SPET- nuclides, radionuclide generators, radiopharmaceuticals for imaging the heart, infection- and lung diagnostics, groups of brain radiopharmaceuticals, PET-kinetic modelling, molecular imaging, application in nuclear medicine, tumor-affine radiopharmaceuticals, targeted radionuclide therapy, radiopharmaceutical synthesis.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts: <a href="http://www.pharma.ethz.ch/scripts/index">http://www.pharma.ethz.ch/scripts/index</a></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: basic knowledge in physics and chemistry</td>
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<tr>
<td>535-0165-00L</td>
<td>Clinical Microbiology</td>
<td>O</td>
<td>1</td>
<td>1V</td>
<td>K. Lucke</td>
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<tr>
<td>Abstract</td>
<td>Thorough knowledge of major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.</td>
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<tr>
<td>Objective</td>
<td>Thorough knowledge of all major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.</td>
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<tr>
<td>Content</td>
<td>Basics and principles of clinical microbiology: - host-pathogen interaction - symptoms and diagnosis of major bacterial pathogens - therapeutic regimens commonly used against bacterial disease - major aspects of medical mycology, virology and parasitology - epidemiology - Brock, Mikrobiologie, Pearson, 13. aktualisierte Auflage - Kayser F. et al., Medizinische Mikrobiologie, Thieme, Stuttgart, New York</td>
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<tr>
<td>Literature</td>
<td>Aktuelle Auflage (derzeit 12. Auflage 2010)</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Basic knowledge of biochemistry, general microbiology, immunology</td>
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Laboratory Courses 3rd Year

Data: 06.11.2018 12:57  Autumn Semester 2016
Respective lectures must be attended before/together with the Laboratory Courses. Special schedule for the Laboratory Courses.

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>535-0219-00L</td>
<td>Laboratory Course in Pharmaceutical Analytics</td>
<td>O</td>
<td>3</td>
<td>7P</td>
<td>C. Steuer</td>
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<tr>
<td>Abstract</td>
<td>Solving analytical problems; Development and interpretation of analytical methods.</td>
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<tr>
<td>Objective</td>
<td>Solving analytical problems; Development and interpretation of analytical methods.</td>
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<tr>
<td>Content</td>
<td>Solving analytical problems. Development and interpretation of analytical methods.</td>
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<tr>
<td>Literature</td>
<td>Skript Pharmazeutische Chemie Praktikum</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Requirements</td>
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Solving analytical problems; Development and interpretation of analytical methods.

SR 2004: 2 credits Analytical Chemistry (529-1041-00), lecture Pharmaceutical Analytics
SR 2013: 6 credits Analytical Chemistry or 36 credits of compulsory lectures 2nd year.

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<tr>
<th>Number</th>
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<tr>
<td>535-0166-00L</td>
<td>Medical Microbiology Practical Course</td>
<td>O</td>
<td>1</td>
<td>1G</td>
<td>A. Lehner</td>
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<tr>
<td>Abstract</td>
<td>Supplement to the parallel lecture in Medical Microbiology.</td>
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<tr>
<td>Objective</td>
<td>Analysis of simulated clinical specimens using classical methods of Medical Microbiology (microscopy, culture etc.). Main aims are the detection and identification of bacterial, mycobacterial and mycological pathogens as well as microbial susceptibility testing. Safe lab-technical handling is imperative, because pathogens of risk groups 1 and 2 are cultured. Therefore aseptic techniques need to be learned together with the basics in sterilization, disinfection and preservation. Basics of Bio-Safety.</td>
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<tr>
<td>Content</td>
<td>Simulated patient specimens representing ca. 50 realistically constructed cases are analysed. The students work in groups and gain insight into the procedures in a routine clinical microbiological laboratory. Using a scriptum, they learn how to identify pathogens and test them for antimicrobial susceptibility. As single groups can work only on a fraction of the cases, results and observations are shared by short presentations through all groups.</td>
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<tr>
<td>Lecture notes</td>
<td>The scriptum (in German) will be distributed at the beginning of the course. It contains all protocols necessary for the practical work</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Requirements: Registration for the course until 15 October; Attendance of the lecture Medicinal Microbiology in the same semester or earlier; Basic skills in careful laboratory work.</td>
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Content

535-0239-00L

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<th>Number</th>
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<th>Type</th>
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<tbody>
<tr>
<td>Practical Course in Medicinal Chemistry</td>
<td>O</td>
<td>3</td>
<td>7P</td>
<td>J. Hall, M. Detmar, C. Halin Winter, D. Neri</td>
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</tr>
<tr>
<td>Abstract</td>
<td>The course comprises experiments relating to concepts of medicinal chemistry including statistical processing, fitting of experimental data, computer modeling of protein structures, experimental measurement of affinity constants and kinetic dissociation constants for protein ligands. The chemical stability of a drug will be studied. Basic gene cloning and protein expression will be introduced.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of experimental methods in drug discovery and development</td>
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<tr>
<td>Content</td>
<td>Characterisation of the biophysical and biological properties of drugs.</td>
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<tr>
<td>Lecture notes</td>
<td>Scripts</td>
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<tr>
<td>Literature</td>
<td>- Original literature</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Requirements: Laboratory course in Pharmaceutical Analytics; Lecture Medicinal Chemistry I in the same semester or earlier.</td>
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Complimentary Courses

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<tbody>
<tr>
<td>701-0297-00L</td>
<td>Applied Ecotoxicology</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>K. Fent</td>
</tr>
<tr>
<td>Abstract</td>
<td>Besides regarding basic concepts, this lecture focus on applied aspects of ecotoxicology. Case studies and effects of environmental chemicals on cells, organisms up to ecosystems are regarded. In a multidisciplinary approach based on toxicological concepts, pollutants are analysed, in particular hormonally active compounds and their effects on reproduction.</td>
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<tr>
<td>Objective</td>
<td>This lecture focusses on basic concepts of ecotoxicology and their application to environmental chemicals and environmental pollution problems. Basic concepts are regarded with respect to their consequences for the environment. Toxicological effects on organisms are analysed at different levels of organisation, from the molecular to the ecosystem level. Case studies are regarded in order to understand chemical's actions and their effects. In addition bioaccumulation and their consequences, the methods in ecotoxicology and environmental effects of various compounds will be regarded. Emphasis will be placed on hormonally active compounds and their effects to aquatic organisms. Furthermore, methods of environmental risk assessment of environmental pollutants will be discussed.</td>
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<tr>
<td>Lecture notes</td>
<td>Hochschullehrbuch von K. Fent &quot;Ökotoxikologie. Umweltchemie-Toxikologie-Ökologie&quot; (Georg Thieme Verlag, Stuttgart, 2013, 4. Auflage)</td>
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<tbody>
<tr>
<td>376-0021-00L</td>
<td>Introduction to Biomedical Engineering I</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Christen, R. Müller, J. G. Snedeke, M. Zenobi-Wong</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering. Understanding of physical and technical principles in biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering. Mathematical description and problem solving. Knowledge of biomedical engineering applications in research and clinical practice.</td>
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<tr>
<td>Objective</td>
<td>Tissue and Cellular Biomechanics, Molecular Biomechanics and Biopolymers, Computational Biomechanics, Biomaterials, Tissue Engineering, Radiation and Radiographic Imaging, Diagnostic Ultrasound Imaging, Magnetic Resonance Imaging, Biomedical Optics and Lasers.</td>
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<tr>
<td>Content</td>
<td>Stored on ILIAS.</td>
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<tr>
<td>Lecture notes</td>
<td>Introduction to Biomedical Engineering, 3rd Edition 2011.</td>
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<tr>
<td>Literature</td>
<td>Autor: John Endertle, Joseph Bronzino, ISBN 9780123749796</td>
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<tr>
<td>376-1305-00L</td>
<td>Development of the Nervous System</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>E. Stoeckl, further lecturers</td>
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<tr>
<td>Abstract</td>
<td>The course covers the development of the nervous system (NS) with a focus on neurogenesis and migration, axon growth, synapse formation, mol. &amp; cell. mechanisms, and diseases of the developing NS. The aim is to give a deepened insight on the normal development, of the nervous system based on molecular, cellular and biochemical approaches.</td>
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| Notice      | 535-0329-00L | O        | 3    | 7P    | J. Hall, M. Detmar, C. Halin Winter, D. Neri |

Data: 06.11.2018 12:57
Autumn Semester 2016
Page 1208 of 1571
The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

Lecture notes
Must be downloaded from OLAT: https://www.olat.uzh.ch/olat/dmz/ as BIO344

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

Prerequisites / notice
None. Bring something to write and your student ID

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<tr>
<td>376-1305-01L</td>
<td>Structure, Plasticity and Repair of the Nervous System</td>
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<td>English</td>
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<tr>
<td>376-1714-00L</td>
<td>Biocompatible Materials</td>
<td>4</td>
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</table>

Abstract
The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

Objective
The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content
The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes
ETH students: Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

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<th>Course Code</th>
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<tbody>
<tr>
<td>551-0313-00L</td>
<td>Microbiology (Part I)</td>
<td>3</td>
<td>English</td>
</tr>
<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>3</td>
<td>English</td>
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</table>

Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

Lecture notes
Handouts can be accessed online.

Literature
(available online via ETH library)

Current literature references will be provided during the lectures.

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

Handouts provided during the classes and references therein.

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<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>3</td>
<td>English</td>
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Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Lecture notes
Handouts can be accessed online.

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

Prerequisites / notice
None. Bring something to write and your student ID

Handouts provided during the classes and references therein.

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Abstract
Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Objective
This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Content
Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Lecture notes
Updated handouts will be provided during the class.

Literature
Current literature references will be provided during the lectures.

Prerequisites / notice
None. Bring something to write and your student ID

Handouts provided during the classes and references therein.

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Content
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Lecture notes
Updated handouts will be provided during the class.

Literature
Current literature references will be provided during the lectures.

Prerequisites / notice
None. Bring something to write and your student ID

Handouts provided during the classes and references therein.

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Lecture notes
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Prerequisites / notice
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Content
Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Lecture notes
Updated handouts will be provided during the class.

Literature
Current literature references will be provided during the lectures.

Prerequisites / notice
None. Bring something to write and your student ID

Handouts provided during the classes and references therein.
Food Chemistry II

**Abstract**
To familiarize with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

**Objective**
To familiarize with the structure, properties and reactivity of food constituents. To understand the relationship between multiple chemical reactions and the quality of food.

**Content**
Descriptive chemistry of food constituents (proteins, lipids, carbohydrates, plant phenolics, flavour compounds).

Reactions which affect the colour, flavour, texture, and the nutritional value of food raw materials and food products during processing, storage and preparation in a positive or in a negative way (e.g. lipid oxidation, Maillard reaction, enzymatic browning).

Links to food analysis, food processing, and nutrition.

The lectures Food Chemistry I and Food Chemistry II constitute a unit.

**Lecture notes**
The lectures are supplemented with handouts.

**Literature**

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Food Microbiology I

**Abstract**
This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

**Objective**
The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.

**Content**
1. **History of Food Microbiology**
   1.1. Short synopsis of foodborne microorganisms
   1.2. Spoilage of Foods
   1.3. Foodborne Disease
   1.4. Food Preservation
   1.5. VIP's of Food Microbiology
2. **Overview of Microorganisms in Foods**
   2.1 Origin of foodborne Microorganisms
   2.2. Bacteria
   2.3 Yeasts
   2.4. Molds
   3. **Microbial Spoilage of Foods**
   3.1. Intrinsic and Extrinsic Parameters
   3.2. Meats, Seafoods, Eggs
   3.3. Milk and Milk Products
   3.4. Vegetable and Fruit Products
   3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   3.6. Drinks and Canned Foods
4. **Foodborne Disease**
   4.1. Significance and Transmission of Foodborne pathogens
   4.2. Staphylococcus aureus
   4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4.4. Listeria monocytogenes
   4.5. Salmonella, Shigella, Escherichia coli
   4.6. Vibrio, Yersinia, Campylobacter
   4.7. Brucella, Mycobacterium
   4.8. Parasites
   4.9. Viruses and Bacteriophages
   4.10. Mycotoxins
   4.11. Bioactive Amines
   4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

**Lecture notes**
Electronic copies of the presentation slides (PDF) and additional material will be made available for download.

**Literature**
Recommendations will be given in the first lecture

---

Biomechanics of Sports Injuries and Rehabilitation

**Abstract**
This lecture introduces the basic principles of injury mechanics and rehabilitation focussing on sports injuries.

**Objective**
Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

**Content**
This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented. Furthermore possibilities to prevent injuries are discussed. Thereby the lecture focuses on sports injuries.

**Lecture notes**
Handouts will be made available.

**Literature**

---

Molecular Biology of Foodborne Pathogens

**Abstract**
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

**Objective**
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganisms or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

**Content**
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and pathogenic factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

**Lecture notes**
Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

**Literature**
Recommendations will be given in the first lecture
### Functional Microorganisms in Foods

**Abstract**
This integrated course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

**Objective**
To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

**Content**
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:
- **Probiotics and Prebiotics:** Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- **Bioprotective Cultures and Antimicrobial Metabolites:** Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- **Legal and Protection Issues Related Functional Foods**
- **Industrial Biotechnology of Flavor and Taste Development**
- **Safety of Food Starter Cultures and Probiotics**

**Lecture notes**
Copy of the power point slides from lectures will be provided.

**Literature**
A list of references will be given at the beginning of the course for the different topics presented during this course.

### Dietary Etiologies of Chronic Disease

**Abstract**
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Objective**
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

**Content**
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Lecture notes**
There is no script. Powerpoint presentations will be made available on-line to students.

**Literature**
To be provided by the individual lecturers, at their discretion.

**Prerequisites / notice**
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

### Epidemiology and Prevention

**Abstract**
The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development of preventive and treatment interventions and to improved population health.

**Objective**
The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.

**Content**
The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

### Food Biotechnology

**Abstract**
Basic information for understanding biotechnology applied to food processing will be presented. This will include a presentation of the physiology of important productive microorganisms used in food fermentations, closely related to applications in biotechnology; microbial kinetics, and design and operation of bioreactors; and application of modern molecular tools for food biotechnology.

**Objective**
The main goal for this course is to provide students with basic information for understanding biotechnology applied to food processing. For the students, the aim will be:
- To understand the important role of microbial physiology and molecular tools for food biotechnology;
- To understand basic principles of fermentation biotechnology with particular emphasis on food applications.

**Content**
Biotechnology has been defined as any technique that uses living organisms, or substances from those organisms, to make or modify a product, to improve plants or animals, or to develop microorganisms for specific uses. In this course, basic knowledge for understanding biotechnology as applied to food processing will be presented. This course builds on the application of principles learned from other basic courses in the Bachelor program, especially microbiology and microbial metabolism, molecular biology, biochemistry, physics and engineering. Students will learn about the physiology of important productive microorganisms (lactic acid bacteria, bifidobacteria, propionibacteria and fungi) used in food fermentations, closely related to applications in biotechnology. Microbial kinetics, and design and operation of bioreactors used for both research and industrial scale production of traditional foods and modern food ingredients will be presented. This part will be illustrated by examples of food fermentation processes, representative of specific challenges. Finally, the application of modern molecular tools to food biotechnology will be discussed.

**Lecture notes**
A complete course document and/or a copy of the power point slides from each lecture will be provided.

**Literature**
A list of references will be given at the beginning of the course for the different topics presented during the course.
Recommended GESS Science in Perspective (Type B) for D-CHAB.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

### Pharmaceutical Sciences Bachelor - Key for Type

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### Key for Hours

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ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Pharmaceutical Sciences Master

First Year

Compulsory and Compensatory Courses

Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>535-0010-00L</td>
<td>Drug Seminars I</td>
<td>O</td>
<td>0</td>
<td>1S</td>
<td>D. Neri</td>
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<tr>
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<td>6 credit points are awarded after successful presentation in the Seminar Week. - Strictly for students enrolled in the Master programmes Pharmaceutical Sciences or MIPS</td>
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<tr>
<td>Abstract</td>
<td>Drug therapy is nothing less than interference with a highly complex biological system, which is affected by various internal and external factors. A profound understanding of drug effects thus requires a transdisciplinary approach of investigation. The drug seminars provide a platform for the presentation and discussion of these transdisciplinary approaches for the investigation of drug action.</td>
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<td>Content</td>
<td>The faculty members of the Institute of Pharmaceutical Sciences offer specific projects from different areas of the pharmaceutical sciences, each of which is elaborated by a small groups of students (4-8). Each group is tutored by a faculty member. The objective of this work is to achieve an in-depth understanding of the problem investigated and to present the results of the work to an audience composed of all students participating in the drug seminar and the faculty of the Institute of Pharmaceutical Sciences. Presentations will take place in the framework of a dedicated mini-symposium, which is part of the external seminar week. The possibility exists to invite external experts from industry or the public health sector to participate in the mini-symposium. Students are strongly encouraged to make use of this option and will again be supported in these efforts by the faculty members.</td>
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<td>535-0030-00L</td>
<td>Therapeutic Proteins</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>C. Halin Winter, D. Neri</td>
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<td></td>
<td>In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed. Furthermore, students will expand their training in pharmaceutical immunology and will be introduced to the basic concepts of pharmaceutical product quality management.</td>
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<tr>
<td>Abstract</td>
<td>Students know and understand: - basic mechanisms and regulation of the immune response - the pathogenic mechanisms of the most important immune-mediated disorders - the most frequently used expression systems for the production of therapeutic proteins - the use of protein engineering tools for modifying different features of therapeutic proteins - the mechanism of action of selected therapeutic proteins and their application - basic concepts in the GMP production of therapeutic proteins</td>
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</tr>
<tr>
<td>Objective</td>
<td>The course consists of two parts: In a first part, students will complete their training of pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenic mechanisms of immune-mediated diseases. Deepened knowledge of immunology will be relevant for understanding the mechanism of action of many therapeutic proteins, as well as for understanding one major concern related to the use of protein-based drugs, namely, immunogenicity. The second part focuses on topics related to the development and application of therapeutic proteins, such as protein expression, protein engineering, reducing immunogenicity, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.</td>
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</tr>
<tr>
<td>Content</td>
<td>The course consists of two parts: In a first part, students will complete their training of pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenic mechanisms of immune-mediated diseases. Deepened knowledge of immunology will be relevant for understanding the mechanism of action of many therapeutic proteins, as well as for understanding one major concern related to the use of protein-based drugs, namely, immunogenicity. The second part focuses on topics related to the development and application of therapeutic proteins, such as protein expression, protein engineering, reducing immunogenicity, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Handouts to the lectures will be available for downloading under <a href="http://www.pharma.ethz.ch/scripts/index">http://www.pharma.ethz.ch/scripts/index</a></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.) - Lecture Handouts - Paper References provided in the Scripts - EMEA Dossier for Humira</td>
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<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>535-0041-00L</td>
<td>Pharmacology and Toxicology III</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>M. Detmar, U. Quitterer</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course is divided into two parts. The first part provides a detailed understanding of drugs and pharmacotherapy of infectious diseases and cancer. The second part gives an overview of the field of pharmacogenomics with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>The course advances basic knowledge in pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects of drug therapy in the fields of infectious diseases and cancer. The course also provides an overview of the field of pharmacogenomics, with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.</td>
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<tr>
<td>Content</td>
<td>Topics include the pharmacology and pharmacotherapy of infectious diseases and cancer. In the field of pharmacogenomics, the course is focused on genetics, genome-wide association studies, genetic disease predisposition, examples of genetic variability of drug metabolism and drug responses, identification of new drug targets, relevance of pharmacogenomics for clinical drug development, and toxicogenomics.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>A script is provided for each lecture course. The scripts define important and exam-relevant contents of lectures. Scripts do not replace the lecture.</td>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>535-0050-00L</td>
<td>Pharmacopoeidemiology and Drug Safety</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>S. Russmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to the principles, methods and applications of pharmacoepidemiology and drug safety. Drug safety in the pharmaceutical industry and regulatory authorities, but also for hospital and office pharmacists. Another focus is the evaluation and interpretation of pharmacoepidemiological drug safety studies in the medical literature and the evaluation of benefits vs. risks.</td>
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</table>

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1213 of 1571
Objective: The practical course is open for master and graduate students to get an introduction into hands-on computer-assisted drug design. The course offers the possibility for people with and without computational and or laboratory background to get an introduction into the study of drug safety and xenobiotics. Participants become familiar with state-of-the-art methodologies in a real-life computer-aided medicinal chemistry project. Participants will learn about computational algorithms and advanced experimental approaches to drug discovery and design, including theoretical, quantitative structure activity relationship (QSAR) methods, and medicinal chemistry, so that participants will be able to use relevant computer-based methods in own research projects.

Content:
- Knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics.
- Knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics.
- Toxic reactions of metabolites. Factors which affect the biotransformation.
- Factors which affect the biotransformation.

Prerequisites / notice:
The class is organized as a two-week block course. Additional selected literature will be provided during the lecture.

Literature:
- Strom, Kimmel, Hennessy: Textbook of Pharmacoepidemiology

Compensatory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0023-00L</td>
<td>Computer-Assisted Drug Design (Practical Course)</td>
<td>W Dr</td>
<td>4 credits</td>
<td>6P</td>
<td>G. Schneider, J. A. Hiss</td>
</tr>
<tr>
<td>535-0024-00L</td>
<td>Methods in Drug Design</td>
<td>W Dr</td>
<td>1 credit</td>
<td>1V</td>
<td>G. Schneider</td>
</tr>
</tbody>
</table>

Elective courses can be used as compensatory courses.

Elegants

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0250-00L</td>
<td>Biotransformation of Drugs and Xenobiotics</td>
<td>W Dr</td>
<td>1 credit</td>
<td>1V</td>
<td>S.D. Krämer</td>
</tr>
</tbody>
</table>

Compulsory for the students of the practical course, open for other interested students.

Recommended literature:
- Historical landmarks of drug safety
- Pharmacovigilance and causality assessment
- Drug safety in premarketing clinical trials
- Descriptive, cohort and case-control drug safety study designs; Data analysis and control of confounding
- Pharmacokinetics and regulatory decision making in drug safety; Risk management plans (RMPs)
- Clinical Decision Support Systems, Interventional Pharmacoepidemiology
- Pharmacoepidemiological databases, "Big Data"
- Interactive discussion of many real-life examples for each topic

Lecture notes:
This course will be a combination of formal lectures, group discussions and self-directed studies. Course material will be taught through seminars, case studies in small groups. Reading material and scripts will be provided for each week.

Lecture notes:
Detailed information will be handed out during the course.

Lecture notes:
The class is organized as a two-week block course.

Lecture notes:
The number of participants is limited.

Lecture notes:
The lecture is mandatory for all participants of the course "Computer-Assisted Drug Design" (535-0023-00).

Lecture notes:
Kick-off meeting and confirmation of registration (Vorbesprechung und Platzvergabe): During the last lecture of the class "Computer-Assisted Drug Design" (535-0022-00).

Ideally, students interested in the course participated and successfully passed the lecture "Computer-Assisted Drug Design" (535-0022-00).

Lecture notes:
The lecture is mandatory for all participants of the course "Computer-Assisted Drug Design" (535-0023-00).
535-0137-00L

**Clinical Chemistry II**

**W Dr** 1 credit 1V  M. Hersberger

**Abstract**

Detailed knowledge on particular aspects of clinical chemistry and medical laboratory diagnostics concerning quality control, point-of-care analytics, analytics of kidney stones, tumor markers, diagnosis of HIV and hepatits, pharmacogenetics, thyroid function, bone metabolism and laboratory diagnosis of hypertension.

**Objective**

Detailed knowledge on the implementation and interpretation of clinical laboratory diagnostic tests. Competence to interpret selected tests.

**Content**

Internal and external quality control, point-of-care analytics, analytics of kidney stones, use of tumor marker determinations, diagnosis of HIV and hepatits, pharmacogenetics, thyroid function, bone metabolism and laboratory diagnosis of hypertension.

**Literature**

- Jürgen Hallbach, Klinische Chemie und Hämatologie für den Einstieg, Thieme Verlag
- Harald Renz, Praktische Labordiagnostik, de Gruyter Verlag
- Walter Guder, Das Laborbuch für Klinik und Praxis, Elsevier Verlag
- Lothar Thomas, Labor und Diagnose, TH Books
- William Marshall, Clinical Chemistry, Mosby Ltd.
- Tuan H.B. Wu, Tietz, Clinical Guide to Laboratory Tests, Saunders

**Prerequisites / notice**

Requirement: basic knowledge in clinical chemistry and laboratory diagnostics

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535-0015-00L

**History of Pharmacy**

**W** 1 credit 1V  M. Fankhauser

**Abstract**

The students will receive the basic knowledge of the history of pharmacy. This knowledge will allow them to have a detailed approach to the actual pharmacy and the development of the materia medica.

**Objective**

The students will receive the basic knowledge of the history of pharmacy. This knowledge will allow them to have a detailed approach to the actual pharmacy and the development of the materia medica.

**Content**

In the first part of the lecture we will talk about the position of the pharmacist in the past and in society. We go through the milestones of the social and legal development of pharmacy. The second part will deal with the history of pharmacy with development of therapeutical theories and the evolution of the used remedies. It also includes their sometimes mystical and symbolical dimension.

**Literature**

Wird in der ersten Veranstaltung mitgeteilt.

**Prerequisites / notice**

Voraussetzungen: Keine. Interesse für die Rolle der Pharmazie und der Medikamente in der Vergangenheit von Vorteil.

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535-0344-00L

**From Ethnopharmacy to Molecular Pharmacognosy**

**W Dr** 1 credit 1V  B. Frei Haller, J. Gertsch

**Abstract**

Basic understanding and awareness of ethnopharmaceutical and ethnopharmacological issues and research. Knowledge of methods used in drug discovery from natural sources. Discussion of the issues around law and international treaties. Importance of ethnopharmaceutical knowledge for world health.

**Objective**

Basic understanding and awareness of ethnopharmaceutical and ethnopharmacological issues and research. Knowledge of methods used in drug discovery from natural sources. Discussion of the issues around law and international treaties. Importance of ethnopharmaceutical knowledge for world health.

**Content**

Introduction into ethnopharmacy and related disciplines: definitions of terms, working methods, research projects, bioprospecting. Traditional medicinal plants of different cultures and their role in modern Western medicine (rational application of traditional uses), today's "fashion plants." Empirical, traditional knowledge versus Evidence Based Medicine. The role of biodiversity (CBD, Rio 1992; Nagoya, 2010) and problems associated with drug discovery from natural products. Screening strategies for drug discovery (random screening versus screening based on cultural, ecological, ethnopharmacological, chemotaxonomic criteria). Traditional knowledge in relation to the fight against malaria and its implementation in research, product development and development cooperation. Introduction to and selected examples of herbal drugs and poisons, mode of action, and their ethnopharmacological importance. Critical analysis of bioprospecting as a drug discovery strategy.

**Literature**


**Prerequisites / notice**

Prerequisites: Basic lectures in biology or biochemistry and pharmaceutical biology have been attended; not suitable for first semester students.

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535-0423-00L

**Drug Delivery and Drug Targeting**

**W Dr** 2 credits 2V  J.C. Leroux, D. Brambilla

**Abstract**

The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand and evaluate the field in terms of scientific criteria.

**Objective**

The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. The focus of the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and problems associated with drug delivery. The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

**Literature**

- Harald Renz, Praktische Labordiagnostik, de Gruyter Verlag
- William Marshall, Clinical Chemistry, Mosby Ltd.

**Prerequisites / notice**

Selected lecture notes, documents and supporting material will be directly provided or may be downloaded using [http://www.galenik.ethz.ch/teaching/dv_drug_del_drug_tag](http://www.galenik.ethz.ch/teaching/dv_drug_del_drug_tag)

The website also displays additional information on peroral delivery systems, transdermal systems and systems for alternative routes (nasal, pulmonary) of delivery. These fields are covered in detail in the course Galenische Pharmazie II (Galenical Pharmacy II).

**Further references will be provided in the course.**

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535-0300-00L

**Molecular Mechanisms of Drug Actions and Targets**

**W Dr** 1 credit 1V  V. I. Otto

**Abstract**

On average one drug per year is withdrawn from the market. Using selected examples of such drug failures, the course aims at analyzing and discussing the present explanations of drug actions as well as the predictive power of animal models and clinical trials. In addition, the ethical, societal, and economical expectations in new drugs shall be reflected.

**Objective**

To develop a critical understanding of the relevance and limitations of the current approaches to explaining and anticipating drug effects. To critically appraise the ethical, societal, economical and political expectations in the development of new drugs.

**Number of participants limited to 24.**
In December 2006, Pfizer stopped a large phase III study on the use of Torcetrapib for the prevention of atherosclerosis and cardiovascular disease. 800 million $ in development costs and 21 billion $ in stocks were annihilated overnight. The failure of Torcetrapib has pinpointed the limitations of an extremely reductionist view of atherosclerosis and it's prevention by drug therapy. It has also highlighted what high expectations we have in a safe and wide applicability of drugs and of their economical success. Torcetrapib is not a single case. In the last 10 years, on average one drug per year was withdrawn from the market due to lack of efficacy, unexpected side effects or toxicity. This clearly shows that the common investigations and the modern understanding of drug actions are often not sufficient to predict the effects a drug will have in large patient populations. These are the topics of the present course. Using three particularly informative examples of drug failures, the problems encountered and the concepts and informative value of preclinical and clinical studies will be analyzed and discussed. Furthermore, the ethical, societal, economical and political expectations in new drugs shall be reflected.

Lecture notes
Printouts of the slides used for the lectures and literature for reading and discussions will be available online.

Literature
Recommended reading: John Abramson, Overdo$ed America, Harper Perennial, New York 2008

Prerequisites / notice
Successful participation in this course is required for a research project ("Forschungspraktikum") in the CADD group.

535-0022-00L Computer-Assisted Drug Design
W Dr 1 credit 1V G. Schneider

Abstract
The lecture series provides an introduction to computer applications in medicinal chemistry. A focus is on molecular representations, property predictions, molecular similarity concepts, virtual screening techniques, and de novo drug design. All theoretical concepts and algorithms presented are illustrated by practical applications and case studies

Objective
The students will learn how computer simulation generates ideas for drug design and development, understand the theoretical principles of property prediction and computer-generated compound generation, and understand possibilities and limitations of computer-assisted drug design in pharmaceutical chemistry. As a result, they are prepared for professional assessment of computer-assisted drug design studies in medicinal chemistry projects.

Literature
Recommended textbooks:

Prerequisites / notice
Requirements: basic knowledge in Medicinal Chemistry and Pharmacology. Ability to read and understand scientific publications written in English.

535-0546-00L Patents
W 1 credit 1V A. Koepf, P. Pliska

Abstract
Knowledge in the field of intellectual property, especially of patents and trademarks, with particular emphasis on pharmaceutics. This implies knowing and understanding

Objective
Introduction into intellectual property; prosecution of patent applications; patent information; exploitation and enforcement of patents; peculiarities in pharmaceutics and medicine; social, political and ethical aspects; Trademarks.

Content
1. Introduction into industrial property (patents, trademarks, industrial designs);
2. Prosecution of patent applications (patentability);
3. Patent information (patent publications, databases, searches);
4. Exploitation and enforcement of patents (possibilities of exploitation, licenses, parallel imports, scope of protection, patent infringement);
5. Peculiarities in pharmaceutics and medicine (supplementary protection certificates, experimental use exemption, therapy and diagnosis, medical indication);
6. Social, political and ethical aspects (patents and prices for medicinal products, traditional knowledge and ethnomedicine, bioprospecting and biopiracy, human DNA inventions);
7. Trademarks, types of trademarks, grounds for refusal, peculiarities of pharma-trademarks.

Lecture notes
A script is available in electronic form during the lecture.

Literature

535-0310-00L Glycobiology in Drug Development
W Dr 1 credit 1V V. I. Otto

Abstract
Protein-based drugs constitute around 25% of new approvals and most of them are glycoproteins. Using selected examples the course aims at providing insight into our present knowledge on glycosylation-activity relationships and the production and analysis of glycoprotein-based drugs.

Objective
Gaining insight into the glycobiology of therapeutically used glycoproteins. This implies knowing and understanding

Content
lecture plan:
1. Introduction: Carbohydrates - "life's first language"
2. Tissue plasminogen activator (t-PA), glucocerebrosidase and the biosynthesis of N-glycans
3. PSGL-1 and the biosynthesis of O-glycans;
P-selectin and other lectins
4. The glycoprotein hormones and the production and analysis of therapeutic glycoproteins
5. Monoclonal antibodies and the modification of their therapeutic profile through glycoengineering
6. EPO "the same but different"

Lecture notes
The slides used for the lectures will be provided online

Literature

Prerequisites / notice
Requirements: Basic knowledge in immunology, molecular biology, protein chemistry and analytics. Basic knowledge in pharmacology.

535-0021-00L Vitamins in Health and Disease
W Dr 1 credit 1V C. Müller

Abstract
Vitamins are essential organic compounds that cannot be synthesized by an organism and hence, they have to be acquired from the diet. This lecture will give an overview about the application of vitamins in health and disease.
Objective
The aim of this lecture is a critical examination of the students with the topic of "Vitamins in Health and Disease". The students will get an overview of vitamins, of their medical applications and the role of the pharmacist with "over-the-counter" products.

Content
Deficiencies of particular vitamins result in specific diseases such as for example scurvy (vitamin C deficiency). Such disease patterns are usually easily recognized and facile to be treated. The clinical utility of supplementation concerns people with severe deficiencies and a risk of complications. Latent vitamin deficiencies might result in variable disorders and risks. As an example neurological disorders in elderly as a consequence of chronic lack of vitamin B12 should be mentioned. Subclinical deficiencies are often difficult to assess. However, these are exactly the cases where advice of a pharmacist is requested.

A large intake of vitamins by over-supplementation or food fortification might be dangerous (hypervitaminosis). This is in particular the case for fat-soluble vitamins or in the case of constant intake of high amounts of water-soluble vitamins over a long time period.

The lecture 'Vitamins in Health and Disease' will give an overview over the history and applications of vitamins and their functions to preserve good health. The utility of vitamin supplementation during conditions of deficiencies, potential consequences of a latent deficiency as well as risks of over-supplementation will be discussed.

Lecture notes
Hand-outs will be distributed during the lecture (partly in English, partly in German).

Literature
Book recommendation: reference books:
- Handbuch Nährstoffe, Burgerstein,
  Trias Verlag ISBN 978-3-8304-6071-8
- Arzneimittel und Mikronährstoffe - Medikationsorientierte Supplementierung
  WVG, ISBN 978-3-8047-2779-3

Prerequisites / notice
Requirements: Basic knowledge in biochemistry and pharmacology. Ability to read and understand scientific publications in English.

535-0360-00L Evidence Based Phytotherapy W Dr 1 credit 1V J. Drewe, K. Berger Büter

Abstract
Based on epidemiology, economic importance and evidence-based medicine, basic principles of rational phytotherapy will be discussed: a) identification of drug candidates, b) registration requirements, c) criteria to assess efficacy, d) biomarkers and pharmacokinetics, e) safety and f) principles of extract generation. Important prototypes will be discussed

Objective
Students should learn the importance of rational (= evidence based) pharmacotherapy with herbal extracts:

They should get to know the development process of herbal drugs:
- How are interesting development candidates being identified? What are the strategies?
- What are the regulatory requirements (traditional use, well-established use, new herbal entities)?
- What are the selection criteria?
- Assessment of efficacy (animal-,human studies, biomarker)
- Pharmacokinetics
- Safety (Toxicity, unwanted adverse effects, drug-drug interactions)
- Pharmaceutical quality
- Securing of herbal identity (collections, agriculture)
- Quality management
- selection of appropriate extraction procedures?

Important prototypes will be presented and critically discussed:
- Cannabis sativa
- Crataegus sp.
- Echinacea
- Ginkgo biloba
- Hypericum perforatum
- Iberogast®
- Kava kava
- Pelargonium
- Punica granatum
- Serenoa repens

Content
Effektive Zeiten 14.45 - 15.30; 15.45-16.30)

Einführung: Qualität Arzneipflanzen-Fertigprodukte, Monographien (Kommission E, ESCOP, HMPC), Unterschiede hinsichtlich des Registrierungsstatus und -anforderungen: traditional use, well established use und new herbal entities, Methoden Produktentwicklung (Pflanzenauswahl, Anbau, Extraktentwicklung, präklinische und klinische Entwicklung) - KB

Grundlegende Begriffe der evidenzbasierten Medizin- JD

Hypericum perforatum (inklusive Pyrrolizidinalkaloid problematik)
Ginkgo

05.10.2016
Iberogast (Beispiel eines Multikomponentenproduktes)
Cannabis

12.10.2016
Pflanzliche Nahrungsergänzungsmittel versus Pflanzliche Arzneimittel

19.10.2016
Echinacea
Serenoa repens

26.10.2016
Petasites
Silybum marianum

02.11.2016
Pelargonium
B) MC-Prüfung

Lecture notes
Die Skripten werden vor den jeweiligen Vorlesungen per Email an die Teilnehmer versandt

327-0811-00L Industrial Research and Development at the Interface of Biomaterials and Drug Delivery W Dr 1 credit 1V L. B. Uebersax, J. Goldhahn, F. Schlottig, R. Streicher
This course will provide an up-to-date, comprehensive review of the industrial perspective at the interface of biomaterials and drugs. This covers regulatory, clinical, pre-clinical and manufacturing concepts. The presentations are provided in an effort to maximize the interaction of student and lecturer.

- The student will be able to categorize a drug-biomaterial as a "drug" or a “material” from a regulatory perspective and can summarize general regulatory pathways for material/drug development.
- The student will be able to summarize the current concepts and challenges for the industry at the material-drug interface.

This course will provide an up-to-date comprehensive review of the industrial perspective at the interface of biomaterials and drugs. General concepts related to regulatory affairs or such as cost-conscious planning of manufacturing processes will be covered by interactive case-studies and in close interaction between students and lecturers. The course covers the future at the biomaterial - implant interface - as it is seen by the industry today - and will be reviewed by experienced and long-standing faculty from industry with the aim to provide a balanced, insightful perspective. From that, clinical development concepts, regulatory pathways and real-life case studies will be discussed with the students. Finally the students - working in small groups of 4-5 - will outline a development pathway for an industrial project and present it to the course and in presence of all faculty to receive maximum feedback to their approaches.

The student will become familiar with the major elements required for a successful development and which challenges have to be taken into account to translate an idea into a successful product.

### Research Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>535-0655-00L</td>
<td>Research Project</td>
<td>O</td>
<td>10 credits</td>
<td>20A</td>
<td>Lecturers</td>
</tr>
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</table>

**Abstract**

The Research Project accustoms students to scientific work.

**Objective**

Students work on a current field of research.

**Content**

Students work on a current field of research.

### Master's Thesis

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>535-0660-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>40D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

**Abstract**

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a subject area of Pharmaceutical Sciences as chosen by the student.

### GESS Science in Perspective

**see GESS Science in Perspective: Type A: Enhancement of Reflection Capability**

**see GESS Science in Perspective: Language Courses ETH/UZH**

**Recommended GESS Science in Perspective (Type B) for D-CHAB.**

### Second Year

### Compulsory and Compensatory Block Courses

#### Compulsory Block Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-5501-00L</td>
<td>Applied Pharmacology</td>
<td>O</td>
<td>6 credits</td>
<td>7G</td>
<td>P. Wiedemeier, S. Erni, B. Falch, K. Fünfschilling, A. Gutzeit, I. S. Vogel Kahmann</td>
</tr>
</tbody>
</table>

**Abstract**

Overview of the most important clinical pictures: symptoms, recognition, differentiation, pharmacotherapy for the most important general and special medical indications. Groups of pharmaceutical compounds, representative range of pharmaceutical ingredients, proprietary medicinal products: mechanisms of action, contraindications, therapeutic patterns, side effects, interactions.

**Objective**

Students have a thorough knowledge of all clinical pictures and their symptoms regarding outpatient treatment. They know the main groups of indications including active pharmaceutical self-medication and ingredients, mechanisms of action, pharmacokinetics, pharmacodynamics and dosage. They are also able to identify the relevant side effects and interactions.

**Content**

Pathophysiology of selected clinical pictures and their main symptoms and clinical parameters. Recognition of alarm symptoms and distinction between pharmaceutical self-medication and the need for medical treatment. Detailed coverage of the pharmacology of all fields of indication encountered in outpatient treatment. Outlining of therapeutic strategies and patterns with regard to suitable pharmaceutical compounds, active pharmaceutical ingredients and representative range of proprietary medicinal products. Discussion of the most important mechanisms of action, contraindications, side effects and interactions.

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<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-5502-00L</td>
<td>Pharmaceutical Manufacturing in Small Quantities</td>
<td>O</td>
<td>3 credits</td>
<td>3G</td>
<td>J. Fröhlich, H. Hartenberg, C. Meier</td>
</tr>
</tbody>
</table>

**Abstract**

Hands-on course in pharmaceutical manufacturing in the pharmacy according to “GMP regulations for small quantities” defined in the pharmacopoeia: Design and practical approach in compounding of formulas using the most important dosage forms including their risks and quality assurance.

**Objective**

Students are able to manufacture, to package, to quality-control and document pharmaceutical compounding on their own, “best practice” and according to GMP regulations, using the appropriate techniques. They know the most important properties of active ingredients and excipients frequently used. They achieve the necessary knowledge including the relevant literature and other sources of information, as well as the legal requirements regarding pharmaceutical manufacturing in small quantities.

**Content**

To impart knowledge about the principal techniques and processes in the manufacturing of pharmaceuticals in small quantities (formulas), focusing on the design, manufacturing, quality assurance and risk based self-appraisal including the patient specific dispensing. During the practical training periods: by means of pharmaceutical relevant examples the design, the planning, the manufacturing including the correct use of the equipment, the in-process control, the packaging and the quality assurance are practiced for various dosage forms and recipes. Quality assurance and control are mainly risk adapted considering as well hygiene regulations according to current pharmaceutical practice. The participants will thus improve their general GMP knowledge and skills.
Organisation of institutional environments (emergency hospitals), with special focus on the medication process and institutional pharmaceutical care (continuum of care).

Students understand the concept of continuum of care and its practical implementation. They know the medication process within an institutional environment. They are able to find the necessary information and deal with problems in connection with pharmaceuticals, to evaluate them and to communicate and documentate their findings adequately. They know how a hospital is organised (procedures, possible problems), responsibilities of the different members of the staff and, most importantly, what the function of a hospital pharmacy is.

Principals of the organisation of institutional environments (emergency hospitals), with special focus on medication processes and institutional pharmaceutical care (circulation of medication, continuum of care). Hygiene regulations, medical products, applications, drug formularies, patient files, SOAP notes, kardex study. Participation at interdisciplinary visits, internal trainings and doctors' reports as well as visitation of the emergency room. Drug interaction, generic substitution, quality management and pharmacovigilance.

Introduction to managed care systems (Pharmaceutical Care and Public Health): problems with regard to therapy and approaches to solutions, service, first aid and medicinal products. Methods of illness prevention and health promotion. Important additional assortments including complementary medicine. Law and economy in everyday pharmacy, structures of the national health care system.

Students know the most important concepts and methods of pharmaceutical care of patients with regard to OTC and Rx-only drugs as well as the essential concepts and methods of public health, prevention and health care. They master the basic rules concerning the pharmaceutical triage and their implications. For the clinical pictures covered during the course, they are able to make therapeutic plans or accompany and optimize doctor's orders. Students show an adequate understanding of the rights and duties of pharmacists as medical personnel regarding medical care and service within the framework of the Swiss health care system. They are capable of handling important medical products and instructing patients about their use. Students have the necessary basic skills and applications of first aid and emergency medicine. They know the essence, chances and limits with reference to additional assortments, therapeutic options like phytotherapy, complementary medicine, veterinary pharmacy and non-medical methods of healing. Students have the essential knowledge of legal aspects and regulations concerning pharmacists and know the basics of business administration.

Pharmaceutical Care: possibilities of pharmaceutical care of patients regarding OTC and Rx-only drugs in the officinal pharmacy. Good pharmaceutical triage in practice, introduction to the pharmaceutical validation of prescriptions, recognition of medicinal, patient related, therapeutic problems and the finding of solutions. Choice of therapy (OTC), accompanying and optimizing therapies (Rx), compliance, correct administration of drugs, cooperation with other medical professions in the field of outpatient treatment. Traditional and proactive pharmaceutical service.: development of adequate means of documentations of intervention and consultation as well as pharmaceutical follow-up care. Public health: role and possibilities of officinal pharmacies as partners within the Swiss health care system: primary health care, prevention, campaigns, early detection, instruction and mediation, referral to doctors. Needs of customers, patients and employees, and social interaction. Significance of the medical profession (illness, suffering, promotion of health and well-being). Basic training in first aid, emergency medicine and wound care. Medical products: handling of important applications and instruction of patients. Important and additional forms of therapy and assortments: phytotherapy, complementary medicine, veterinary pharmacy, non-medical methods of healing. Economy and law in everyday pharmacy: overview of the Swiss legal system. Relevant legal framework, jurisdiction and regulations and their meaning with regard to quality assurance for practicing pharmacists. Basics of finance and accounting as well as personnel management and insurance matters.

Organisation and competencies of the various partners within the Swiss health care system, focusing on the intermediate position and the role of pharmacists as part of the medical community.

Compensatory Block Courses

All Elective Block Courses of the second year in Master studies are eligible as Compensatory Block Courses. Elective Block courses take place in Spring Semester.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>376-0152-AAL</td>
<td>Anatomy and Physiology I+II</td>
<td>E-</td>
<td>10 credits</td>
<td>21R</td>
<td>C. Spengler, D. P. Wolfer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Principles of human embryology, anatomy and histology. Basic knowledge of the anatomy and physiology of tissues, the embryonal and postnatal development, the cardiovascular system, kidney, the intestines and the basics of pathology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Basic Knowledge of human embryology, anatomy and histology with focus on vegetative Anatomy; understanding structure - function relationships. Foundations of human anatomy and physiology and basics of clinical pathophysiology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>406-0603-AAL</td>
<td>Stochastics (Probability and Statistics)</td>
<td>E-</td>
<td>4 credits</td>
<td>9R</td>
<td>M. Kalisch</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language &quot;R&quot;.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Content
From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student's t Distribution
Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

Fundamentals of Biology II: Cell Biology
Overview of the possibilities and limitations in clinical laboratory diagnostics. Indications and methods of everyday parameters are known.
The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students
The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures
Theoretical and practical comprehension of analytical chemistry in order to solve pharmaceutical problems.
Introduction into fundamentals of laboratory diagnostics and overview of the laboratory parameters concerning inflammation, lipid metabolism, myocardial infarction, diabetes, kidney function, urinary diagnostics, liver function, blood coagulation, blood count, therapeutic drug monitoring and drugs of abuse screening, common diagnostics of liver diseases, point-of-care diagnostics.


Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students
Content
Objective
The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students

Literature

Topic/Lecturer/Chapter/Pages:
Analyzing cells & molecules / Gebhard Schertler/8/ 439-463;
Membrane structure / Gebhard Schertleri/10/ 565-595;
Compartment and Sorting/ Ulrike Kutay/12+14/641-694/755-758/782-783/315-320/325 -333/Table 6-2/Figure6-20, 6-21, 6-32, 6-34;
Intracellular Membrane Traffic/ Ulrike Kutay/13/695-752;
The Cytoskeleton/ Ulrike Kutay/16/889 - 948 (only the essentials);
Membrane Transport of Small Molecules and the Electrical Properties of Membranes /Sabine Werner/11/597 - 633;
Mechanism of Cell Communication / Sabine Werner/15/813-876;
Cancer/ Sabine Werner/20/1091-1141;
Cell Junctions and Extracellular Matrix/Ueli Suter / 1035-1081;
Stern Cells and Tissue Renewal/Ueli Suter /1217-1262;
Development of Multicellular organisms/ Ernst Hafen/ 21/ 1145-1179 /1184-1198/1198-1213;
Cell Migration/Joao Matos/951-960;
Cell Death/Joao Matos/1021-1032;
Cell Cycle/chromosome segregation/Cell division/Mitosis/Joao Matos/ 963-1018.

535-0135-AAL Clinical Chemistry I E- 1 credit 2R M. Hersberger

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction into fundamentals of laboratory diagnostics and overview of the laboratory parameters concerning inflammation, lipid metabolism, myocardial infarction, diabetes, kidney function, urinary diagnostics, liver function, blood coagulation, blood count, therapeutic drug monitoring and drugs of abuse screening.
Objective
Overview of the possibilities and limitations in clinical laboratory diagnostics. Indications and methods of everyday parameters are known.
Content
Introduction into medical laboratory diagnostics: immunochemical methods, diagnostics of inflammation, acute myocardial infarction, lipid metabolism, diabetes, kidney function and urinary diagnostics, blood coagulation, blood count, therapeutic drug monitoring, drugs of abuse screening, common diagnostics of liver diseases, point-of-care diagnostics.

535-0222-AAL Pharmaceutical Analytics E- 4 credits 9R C. Steuer

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Theoretical and practical comprehension of analytical chemistry in order to solve pharmaceutical problems.
Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycans, nucleotides, fatty acids and phospholipids, and steroids.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Water balance, assimilation, transport in plants; developmental biology, stress physiology.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

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### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**
- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**
Research colloquium

**Prerequisites / notice**
Occasionally, talks may be delivered in German.

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**Physics (General Courses) - Key for Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

**Key for Hours**

<table>
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</tbody>
</table>

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
**Physics Bachelor**

► Bachelor Studies (Programme Regulations 2016)

►► First Year

---

### First Year Compulsory Courses

#### GESS Science in Perspective

### Minor Courses

### First Year Compulsory Courses

#### First Year Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-1151-00L</td>
<td>Linear Algebra I</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>M. Akveld</td>
</tr>
</tbody>
</table>

**Abstract**


**Objective**

- Mastering basic concepts of Linear Algebra
- Introduction to mathematical methods

**Content**

- Basics
- Vectorspaces and linear maps
- Systems of linear equations and matrices
- Determinants
- Endomorphisms and eigenvalues

**Literature**


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-1701-00L</td>
<td>Physics I</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>A. Wallraff</td>
</tr>
</tbody>
</table>

**Abstract**

This course gives a first introduction to Physics. The emphasis is on classical mechanics, together with an introduction to thermodynamics.

**Objective**

Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems.

**Computer Science**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0847-00L</td>
<td>Computer Science</td>
<td>O</td>
<td>5</td>
<td>2V+2U</td>
<td>B. Gärtner</td>
</tr>
</tbody>
</table>

**Abstract**

This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.

**Objective**

The goal of this lecture is an algorithmically oriented introduction to programming.

**Content**

This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.

**Literature**


### First Year Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-1261-07L</td>
<td>Analysis I</td>
<td>O</td>
<td>10</td>
<td>6V+3U</td>
<td>M. Einsiedler</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction to the differential and integral calculus in one real variable: fundamentals of mathematical thinking, numbers, sequences, basic point set topology, continuity, differentiable functions, ordinary differential equations, Riemann integration.

**Objective**

The ability to work with the basics of calculus in a mathematically rigorous way.
### Bachelor Studies (Programme Regulations 2010)

#### First Year

Course Units of the first year can be found in section Bachelor Studies (Programme Regulations 2016) - First Year.

#### Compulsory Courses

##### Second Year Compulsory Courses

#### Examination Block I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2303-00L</td>
<td>Complex Analysis</td>
<td>O</td>
<td>6</td>
<td>3V+2U</td>
<td>R. Pandharipande</td>
</tr>
</tbody>
</table>

**Abstract**
Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, analytic continuation, special functions, conformal mappings, Riemann mapping theorem.

**Objective**
Working Knowledge with functions of one complex variables; in particular applications of the residue theorem

**Literature**
Th. Gamelin: Complex Analysis. Springer 2001

| 401-2333-00L | Methods of Mathematical Physics I | O    | 6    | 3V+2U | C. A. Keller       |

**Abstract**

**Prerequisites / notice**

| 402-2883-00L | Physics III                    | O    | 7    | 4V+2U | J. Home            |

**Abstract**
Introductory course on quantum and atomic physics including optics and statistical physics.

**Objective**
A basic introduction to quantum and atomic physics, including basics of optics and equilibrium statistical physics. The course will focus on quantum mechanics: wavefunctions, operators, Schrödinger's equation, infinite and finite square well potentials, harmonic oscillator, hydrogen atoms, spin.

**Content**
Atomic structure: Perturbation to basic structure, including Zeeman effect, spin-orbit coupling, many-electron atoms. X-ray spectra, optical selection rules, emission and absorption of radiation, including lasers.

**Lecture notes**
Lecture notes will be provided electronically during the course.

**Literature**


Statistical mechanics: "Statistical Physics", F. Mandl 0-471-91532-7
Introduction to single-particle quantum mechanics. Familiarity with basic ideas and concepts (quantisation, operator formalism, symmetries, and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.

### Third Year Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0205-00L</td>
<td>Quantum Mechanics I</td>
<td>O</td>
<td>10</td>
<td>3V+2U</td>
<td>T. K. Gehrmann</td>
</tr>
</tbody>
</table>

Abstract: Introduction to non-relativistic single-particle quantum mechanics. In particular, the basic concepts of quantum mechanics, such as the quantisation of classical systems, wave functions and the description of observables as operators on a Hilbert space, and the formulation of symmetries will be discussed. Basic phenomena will be analysed and illustrated by generic examples.

Objective: Introduction to single-particle quantum mechanics. Familiarity with basic ideas and concepts (quantisation, operator formalism, symmetries, perturbation theory) and generic examples and applications (bound states, tunneling, scattering states, in one- and three-dimensional settings). Ability to solve simple problems.

Content: Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), symmetries (translations, rotations), quantum mechanics in one dimension, spherically symmetric problems in three dimensions, scattering theory, perturbation theory, variational techniques, spin, addition of angular momenta, relation between QM and classical physics.

Literature: F. Schwabl: Quantum mechanics
J.J. Sakurai: Modern Quantum Mechanics
C. Cohen-Tannoudji: Quantum mechanics I

### Core Courses

#### Core Courses in Experimental Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0263-00L</td>
<td>Astrophysics I</td>
<td>W</td>
<td>10</td>
<td>3V+2U</td>
<td>A. Refregier</td>
</tr>
</tbody>
</table>

Abstract: This introductory course will develop basic concepts in astrophysics as applied to the understanding of the physics of planets, stars, galaxies, and the Universe.

Objective: The course provides an overview of fundamental concepts and physical processes in astrophysics with the dual goals of: i) illustrating physical principles through a variety of astrophysical applications; and ii) providing an overview of research topics in astrophysics.

Content: The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other more specialized lectures. The central topics are: solids and their lattice structures; interatomic bindings; lattice dynamics, electronic properties of insulators, metals, semiconductors, transport properties, magnetism, superconductivity.

Lecture notes: A Manuscript is distributed.

Literature: Ibach & Lüth; Festkörperphysik
C. Kittel, Festkörperphysik
Ashcroft & Mermin, Festkörperphysik
W. Känzig, Kondensierte Materie

Prerequisites / notice: Voraussetzungen: Physik I, II, III wünschenswert

#### Core Courses in Theoretical Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</tr>
</thead>
<tbody>
<tr>
<td>402-0205-00L</td>
<td>Quantum Mechanics I</td>
<td>W</td>
<td>10</td>
<td>3V+2U</td>
<td>T. K. Gehrmann</td>
</tr>
</tbody>
</table>

Abstract: Introduction to non-relativistic single-particle quantum mechanics. In particular, the basic concepts of quantum mechanics, such as the quantisation of classical systems, wave functions and the description of observables as operators on a Hilbert space, and the formulation of symmetries will be discussed. Basic phenomena will be analysed and illustrated by generic examples.

Objective: Introduction to single-particle quantum mechanics. Familiarity with basic ideas and concepts (quantisation, operator formalism, symmetries, perturbation theory) and generic examples and applications (bound states, tunneling, scattering states, in one- and three-dimensional settings). Ability to solve simple problems.

Content: Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), symmetries (translations, rotations), quantum mechanics in one dimension, spherically symmetric problems in three dimensions, scattering theory, perturbation theory, variational techniques, spin, addition of angular momenta, relation between QM and classical physics.

Literature: F. Schwabl: Quantum mechanics
J.J. Sakurai: Modern Quantum Mechanics
C. Cohen-Tannoudji: Quantum mechanics I

### Practical Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0000-01L</td>
<td>Physics Lab I</td>
<td>O</td>
<td>4</td>
<td>1V+4P</td>
<td>A. Biland, M. Doebeli, M. Kroner, S. P. Quanz</td>
</tr>
</tbody>
</table>

Abstract: Introductory lab course in experimental physics with accompanying lecture
Objective
Übergeordnetes Thema des Praktikums und der Vorlesung ist die Auseinandersetzung mit den grundlegenden Herausforderungen eines physikalischen Experimentes. Am Beispiel einfacher experimenteller Aufbauten und Aufgaben stehen vor allem folgende Gesichtspunkte im Vordergrund:

- Motivation und Herangehensweise in der Experimentalphysik
- Praktischer Aufbau von Experimenten und grundlegende Kenntnisse von Messmethoden und Instrumenten
- Einführung in relevante statistische Methoden der Datenauswertung und Fehleranalyse
- Kritische Beurteilung und Interpretation der Beobachtungen und Ergebnisse
- Darstellen und Kommunizieren der Ergebnisse mit Graphiken und Text
- Ethische Aspekte der experimentellen Forschung und wissenschaftlicher Kommunikation

Content
Versuche zu Themen aus den Bereichen der Mechanik, Optik, Wärme, Elektrizität und Kernphysik mit begleitender Vorlesung zur Vertiefung des Verständnisses der Datenanalyse und Interpretation

Lecture notes
Anleitung zum Physikalischen Praktikum; Vorlesungsskript

Prerequisites / notice
Aus einer Liste von 33 Versuchen müssen 9 Versuche in Zweiergruppen durchgeführt werden.

Am ersten Termin findet nur eine dreistündige Einführungsveranstaltung im Hörsaal statt und es werden noch keine Experimente durchgeführt.

402-0241-00L Advanced Physics Laboratory I

9 credits
O 18P C. Grab, T. M. Ihn

Abstract
This laboratory course provides basic training of experimental skills. These are experimental design, implementation, measurement, data analysis and interpretation, as well as error analysis. Written manuals for the individual experiments are available.

402-0240-00L Advanced Physics Laboratory II

9 credits
W 18P C. Grab, T. M. Ihn

Abstract
This laboratory course provides basic experimental skill training for performing physics experiments, including: Implementation of physics experiments using an instruction manual. Planning, designing, realizing, analyzing, and interpreting experiments. Estimating measurement precision.

Objective
Students should learn how to perform a bit more complex experiments, analyze the data and interpret the results.

Proseminars, Experimental and Theoretical Semester Papers

To organise a semester project take contact with one of the instructors.

Not all lecturers are directly eligible in myStudies if "Professors" is the required type of lecturers. In such cases please take contact with the Study Administration (www.phys.ethz.ch/studies/study-administration.html).

Number Title Type ECTS Hours Lecturers

402-0210-96L Proseminar Theoretical Physics: Solitons and Instantons in Condensed Matter

9 credits
W 4S V. Geshkenbein

Abstract
A guided self-study of original papers and of advanced textbooks in theoretical physics. Within the general topic, determined each semester, participants give a presentation on a particular subject and deliver a written report.

402-0217-BSL Theoretical Semester Project in a Group of the Physics Department

9 credits
W 18A


Abstract
This course unit is an alternative if no suitable "Proseminar Theoretical Physics" is available or if the proseminar is already overbooked. Vorträge können ein zusätzlicher Bestandteil der Leistungskontrolle sein.

Prerequisites / notice
Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit. Vorträge können ein zusätzlicher Bestandteil der Leistungskontrolle sein.

402-0215-BSL Experimental Semester Project in a Group of the Physics Department

9 credits
W 18A Professors

Abstract
The aim of the project is to give the student experience in working in a research environment, carrying out physics experiments, analysing and interpreting the resulting data.

Prerequisites / notice
Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit.

402-0510-BSL Advanced Solid State Physics Experiments

9 credits
W 18P

Supervisors for this experimental semester paper:
Prof. Christian Degen
Prof. Leonardo Degan
Prof. Klaus Ensslin
Prof. Thomas Ihn
Prof. Joël Mesot
Prof. Danilo Pescia
Prof. Andreas Vaterlaus
Prof. Andreas Wallraff
Prof. Werner Wegscheider
Prof. Andrey Zhitenev

Abstract
Experiments in condensed matter physics. The work includes the planning, build-up, data taking and analysis, and interpretation of the experimental results.

Objective

Content

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1227 of 1571
Arbeiten in einer Forschungsgruppe sind besonders gut geeignet, die Studierenden mit aktuellen Forschungsthemen und mit moderner Instrumentierung bekannt zu machen.

**402-0400-BSL**

**Advanced Quantum Electronics Experiments**

**W** 9 credits 18P

**Advisors for this experimental semester paper:**
- Prof. Tilman Esslinger
- Prof. Jérôme Faist
- Prof. Rachel Grange
- Prof. Jonathan Home
- Prof. Atac Imamoglu
- Prof. Steven Johnson
- Prof. Ursula Keller

**Abstract**

Implementation of experiments in quantum electronics. Planning, design, realisation, evaluation, and interpretation of the experiments.

**Content**


**402-0719-BSL**

**Particle Physics at PSI (Paul Scherrer Institute)**

**W** 9 credits 18P

**C. Grab**

**Abstract**

During semester breaks 6-12 students stay for 3 weeks at PSI and participate in a hands-on course on experimental particle physics. A small real experiment is performed in common, including apparatus design, construction, running and data analysis. The course includes some lectures, but the focus lies on the practical aspects of experimenting.

**Objective**

Students learn all the different steps it takes to perform a complete particle physics experiment in a small team. They acquire skills to do this themselves in the team, including design, construction, data taking and data analysis.

**402-0717-BSL**

**Particle Physics at CERN**

**W** 9 credits 18P

**F. Nessi-Tedaldi, W. Lustermann**

**Abstract**

During the semester break participating students stay for 4 weeks at CERN and perform experimental work relevant to our particle physics projects. Dates to be agreed upon.

**Objective**

Students learn, by doing, the needed skills to perform a small particle physics experiment: setup, problem solving, data taking, analysis, interpretation and presentation in a written report of publication quality.

**Content**

Detailed information in: http://www@cmsdoc.cern.ch/~nessif/ETHTeilchenpraktikumCERN.html

**Prerequisites / notice**

Language of instruction: English or German

**402-0340-BSL**

**Medical Physics**

**W** 9 credits 18P

**A. J. Lomax, K. P. Prüssmann, M. Rudin**

**Abstract**

In agreement with the lecturers a semester paper in the context of the topics discussed in the lectures can be written.

**GESS Science in Perspective**

see Science in Perspective: Type A: Enhancement of Reflection Capability

Recommended Science in Perspective (Type B) for D-PHYS.

**Language Courses**

see Science in Perspective: Language Courses ETH/UZH

**Additional Courses, Seminars and Colloquia**

**First or Second Year Additional Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0351-00L</td>
<td>Astronomy</td>
<td>Z</td>
<td>2</td>
<td>2V</td>
<td>H. M. Schmid, W. Schmutz</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>An overview on the important topics in modern astronomy: planets, sun, stars, milky way, galaxies, and cosmology.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>This lecture gives a general introduction to main topics in modern astronomy. The lecture provide a basis for the more advanced lectures in astrophysics.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Planeten, Sonne, Sterne, Milchstrasse, Galaxien und Kosmologie.</td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Kopien der Präsentationen werde zur Verfügung gestellt.</td>
<td></td>
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<table>
<thead>
<tr>
<th>401-1511-00L</th>
<th>Geometry</th>
<th>Z</th>
<th>3</th>
<th>2V+1U</th>
<th>T. Ilmanen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>We will study the topology and geometry of 2 and 3 dimensional spaces (manifolds) from an informal point of view. -what is it like to live in a non-Euclidean space (for example, in a surface)? -orientation, genus, curvature -classification of closed orientable surfaces -spherical, Euclidean, and hyperbolic geometry -3-manifolds a la Thurston</td>
<td></td>
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<tr>
<td><strong>Objective</strong></td>
<td>Jeffrey R. Weeks. The Shape of Space.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Literature</strong></td>
<td>Edwin A. Abbott. Flatland. 1884.</td>
<td></td>
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</table>
### Additional Courses

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>402-0247-00L</td>
<td>Electronics for Physicists I (Analogue)</td>
<td>Z</td>
<td>4</td>
<td>2V+2P</td>
<td>R. Horisberger</td>
</tr>
</tbody>
</table>

**Abstract**
Passive elts, linear complex networks, transmission lines, simulation of analog circuits, semiconductor elts: diodes, bipolar and fieldeffect transistors, basic amplifier circuits, small signal analysis, differential amplifiers, noise in analog circuits, operational amplifiers, OTAs, gyrator circuits, feedback and stability in amplifiers, oscillators, ADC's and DAC's, introduction in CMOS technology. Practical excercises in small groups to the above themes complement the lectures.

**Prerequisites / notice**

### Additional Courses (from Second Year Mathematics Bachelor)

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2003-00L</td>
<td>Algebra I</td>
<td>Z</td>
<td>7</td>
<td>4V+2U</td>
<td>L. Halbeisen</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction and development of some basic algebraic structures - groups, rings, fields.

**Objective**
Introduction to basic notions and results of group, ring and field theory.

**Content**
Group Theory: basic notions and examples of groups; Subgroups, Quotient groups and Homomorphisms, Sylow Theorems, Group actions and applications.

Field Theory: basic notions and examples of fields; finite fields, applications.

At the end we prove Mordell's Theorem for special elliptic curves.

**Literature**
J.F. Humphreys: A Course in Group Theory (Oxford University Press)
G. Smith and O. Tabachnikova: Topics in Group Theory (Springer-Verlag)
M. Artin: Algebra (Birkhaeuser Verlag)
B.L. van der Waerden: Algebra I & II (Springer Verlag)

### Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
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</table>

**Abstract**
Research colloquium

**Prerequisites / notice**
Occasionally, talks may be delivered in German.

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<tr>
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</table>

**Abstract**
Research colloquium

**Objective**
The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.

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</tr>
</thead>
<tbody>
<tr>
<td>401-5330-00L</td>
<td>Talks in Mathematical Physics</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>A. Cattaneo, G. Felder, M. Gaberdiel, G. M. Graf, H. Knörrer, T. H. Willwacher, University lecturers</td>
</tr>
</tbody>
</table>

**Abstract**
Research colloquium

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<tr>
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</tr>
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<tbody>
<tr>
<td>402-0501-00L</td>
<td>Solid State Physics</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>A. ZHELudev, G. BLATTER, C. DEGEN, K. ENSSLIN, D. PESCIA, M. SIGRIST, A. WALLRAFF</td>
</tr>
</tbody>
</table>

**Abstract**
Research colloquium

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Research colloquium

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</tr>
</thead>
<tbody>
<tr>
<td>402-0600-00L</td>
<td>Nuclear and Particle Physics with Applications</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>A. Rubbia, G. Dissertori, C. Grab, K. S. Kirch, R. Wallny</td>
</tr>
</tbody>
</table>

**Abstract**
Research colloquium

### Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
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</tr>
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<tbody>
<tr>
<td>402-0600-00L</td>
<td>Nuclear and Particle Physics with Applications</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>A. Rubbia, G. Dissertori, C. Grab, K. S. Kirch, R. Wallny</td>
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</table>

**Abstract**
Research colloquium
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<tr>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0893-00L</td>
<td>Particle Physics Seminar</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>T. K. Gehrmann</td>
</tr>
<tr>
<td>402-0700-00L</td>
<td>Seminar in Elementary Particle Physics</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>M. Spira</td>
</tr>
<tr>
<td>402-0369-00L</td>
<td>Research Colloquium in Astrophysics</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>S. Cantalupo, M. Carollo, S. Lilly, A. Refregier, K. Schawinski, H. M. Schmid</td>
</tr>
<tr>
<td>402-0356-00L</td>
<td>Astrophysics Seminar</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>S. Cantalupo, M. Carollo, S. Lilly, A. Refregier, K. Schawinski, H. M. Schmid</td>
</tr>
<tr>
<td>402-0530-00L</td>
<td>Mesoscopic Systems</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>T. M. Ihn</td>
</tr>
<tr>
<td>227-0980-00L</td>
<td>Seminar on Biomedical Magnetic Resonance</td>
<td>E-</td>
<td>0</td>
<td>2K</td>
<td>K. P. Prüssmann, S. Kozerke, M. Rudin</td>
</tr>
<tr>
<td>227-1043-00L</td>
<td>Neuroinformatics - Colloquia (University of Zurich)</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>S.C. Liu, R. Hahnloser, V. Mante, K. A. Martin</td>
</tr>
<tr>
<td>227-1044-00L</td>
<td>Auditory Informatics (University of Zurich)</td>
<td>E-</td>
<td>2</td>
<td>1S</td>
<td>R. Stoop</td>
</tr>
<tr>
<td>402-0396-00L</td>
<td>Recent Research Highlights in Astrophysics (University of Zurich)</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

**Selection of Higher Semester Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0811-00L</td>
<td>Programming Techniques for Scientific Simulations I</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>M. Troyer</td>
</tr>
</tbody>
</table>
Abstract
This lecture provides an overview of programming techniques for scientific simulations. The focus is on advances C++ programming techniques and scientific software libraries. Based on an overview over the hardware components of PCs and supercomputer, optimization methods for scientific simulation codes are explained.

402-0713-00L Astro-Particle Physics I

W 6 credits 2V+1U A. Biland

Abstract
This lecture gives an overview of the present research in the field of Astro-Particle Physics, including the different experimental techniques. In the first semester, main topics are the charged cosmic rays including the antimatter problem. The second semester focuses on the neutral components of the cosmic rays as well as on some aspects of Dark Matter.

Objective
Successful students know:
- experimental methods to measure cosmic ray particles over full energy range
- current knowledge about the composition of cosmic ray
- possible cosmic acceleration mechanisms
- correlation between astronomical object classes and cosmic accelerators
- information about our galaxy and cosmology gained from observations of cosmic ray

Content
First semester (Astro-Particle Physics I):
- definition of ‘Astro-Particle Physics’
- important historical experiments
- chemical composition of the cosmic rays
- direct observations of cosmic rays
- indirect observations of cosmic rays
- ‘extended air showers’ and ‘cosmic muons’
- ‘knee’ and ‘ankle’ in the energy spectrum
- the ‘anti-matter problem’ and the Big Bang
- ‘cosmic accelerators’

Lecture notes
See lecture home page: http://ihp-lx2.ethz.ch/AstroTeilchen/

Literature
See lecture home page: http://ihp-lx2.ethz.ch/AstroTeilchen/

402-0737-00L Energy and Environment in the 21st Century (Part I)

W 6 credits 2V+1U M. Dittmar

Abstract
The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

Objective
Scientists and especially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of today's and tomorrow energy use and the resulting global consequences for the world climate.

The lecture is for students which are interested participate in a rational and responsible debate about the energy problem of the 21st century.

Content
Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human needs/uses?

Energy conservation and the first and second law of thermodynamics
Fossil fuels (our stored energy resources) and their use.

Burning fossil fuels and the physics of the greenhouse effect.

Physics basics of nuclear fission and fusion energy

Controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.

Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.

The problems with nuclear fusion and the ITER project.

Nuclear fusion and fission: "exotic" ideas.

Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.

New clean renewable energy sources and their physical limits (wind, solar, geothermal etc)

Energy perspectives for the next 100 years and some final remarks

Lecture notes
many more details (in english and german) here:

http://ihp-lx2.ethz.ch/energy21/

Literature

Environmental Physics: Boeker and Egbert New York Wiley 1999

Prerequisites / notice
Science promised us truth, or at least a knowledge of such relations as our intelligence can seize:

if never promised us peace or happiness

Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question.

Rather, it's whether or not the theory gives predictions that agree with experiment.

Richard Feynman, 1985
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies in understanding computation by neurons and neuronal circuits, which is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the most important concepts of superconductivity both on phenomenological and microscopic level, including experimental and theoretical aspects.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, and organic surfaces is introduced. The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostucture's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitations of the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism, and to determine the relation between cell morphology and function. 3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.
Basics of probability theory and the theory of stochastic processes in discrete time.

The course covers the basics of inferential statistics.

Introduction to elementary differential geometry and differential topology.

Differential Geometry in $\mathbb{R}^n$:

- Curves in $\mathbb{R}^n$, inner geometry of hypersurfaces in $\mathbb{R}^n$, curvature, Theorema Egregium, special classes of surfaces, Theorem of Gauss-Bonnet.
- Hyperbolic space.
- Differentiable manifolds, tangent bundle, immersions and embeddings in $\mathbb{R}^n$, Sard's Theorem, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.

The hyperbolic space.

- Differential topology: differentiable manifolds, tangent bundle, immersions and embeddings in $\mathbb{R}^n$, Sard's Theorem, transversality, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.

Differential Geometry in $\mathbb{R}^n$:

- manfredo P. do Carmo: Differential geometry of curves and surfaces
- Wolfgang Kühnel: Differentialgeometrie. Curves-surfaces-manifolds
- Christian Bär: Elementary differential geometry
- Differential Topology:
- Dennis Barden & Charles Thomas: An Introduction to Differential Manifolds
- Victor Guillemin & Alan Pollack: Differential Topology
- Morris W. Hirsch: Differential Topology

401-3461-00L Functional Analysis I

This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from neither 401-3461-00L Functional Analysis I nor 401-3462-00L Functional Analysis II for their Bachelor's degree still can have recognised this course for the Master's degree.

Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.

Abstract

Baire category; Banach and Hilbert spaces, bounded linear operators; three fundamental principles: Uniform boundedness, open mapping/closed graph theorem, Hahn-Banach; convexity; dual spaces; weak and weak* topologies; Banach-Alaoglu; reflexive spaces; compact operators and Fredholm theory; closed range theorem; spectral theory of self-adjoint operators in Hilbert spaces.

Lecture notes

Lecture Notes on "Funktionalanalysis I" by Michael Struwe

401-3601-00L Probability Theory

This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from none of the three course units 401-3601-00L Probability Theory, 401-3642-00L Brownian Motion and Stochastic Calculus resp. 401-3602-00L Applied Stochastic Processes for their Bachelor's degree still can have recognised this course for the Master's degree.

Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.

Abstract

Basics of probability theory and the theory of stochastic processes in discrete time.

Objective

This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:

- Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.

Content

This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:

- Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.

Lecture notes

available, will be sold in the course

Literature

- H. Bauer, Probability Theory, de Gruyter 1996
- J. Jacod and P. Protter, Probability essentials, Springer 2004
- D. Williams, Probability with martingales, Cambridge University Press 1991

401-3621-00L Fundamentals of Mathematical Statistics

The course covers the basics of inferential statistics.

Electives (Physics Master)
### Physics Bachelor - Key for Type

<table>
<thead>
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<th>Letter</th>
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<th>Letter</th>
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<td>Courses outside the curriculum</td>
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### Key for Hours

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<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

### ECTS

- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Human Learning (EW1)
This lecture is only apt for students who intend to enrol in the programs "Teaching Diploma" or "Teaching Certificate". It is about learning in childhood and adolescence.

Abstract
This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

Objective
Any aspiring successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

Content
Thematische Schwerpunkte:
Lernen als Verhaltensänderung und als Informationsverarbeitung; Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen; Intelligenztheorien, Geschlechtsunterschiede beim Lernen

Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:
- Testentwicklung
- Gütekriterien von Tests
- Aufgabenkonstruktion
- Datenauswertung
- Rasch-Modell
- Internationale Vergleichstests
- Zulassungstests

Lecture notes
Tagebucheinträge werden zu Beginn jeder Vorlesung thematisiert.

Enrolment only possible with Teaching Diploma or DC matriculation.

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

http://www.uzh.ch/studies/application/mobilitaet_en.html

In this seminar, students establish the scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.

At the end of the seminar, participants will be in a position to:
- describe the scientific fundamentals of test theory and test structure.
- evaluate examples of scientifically-developed tests in their application context.
- if necessary, critically question the performance assessment that they employ in practice and professionalise it still further.

Die konkreten Inhalte des Seminars ergeben sich aufgrund der Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:
- Testentwicklung
- Gütekriterien von Tests
- Aufgabenkonstruktion
- Datenauswertung
- Rasch-Modell
- Internationale Vergleichstests
- Zulassungstests

Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören auch die Handouts der verschiedenen, studentischen Vorträge.

Als Grundlagenliteratur werden folgende Werke empfohlen:
- Weitere Literatur wird in der Lehrveranstaltung genannt.

Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen:
- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)
- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung
- Referat (RE)
- Schreiben einer schriftlichen Arbeit

Weitere Angaben zu den Leistungsanforderungen werden im Rahmen der Startveranstaltung abgegeben und erläutert.

Colloquium on the Science of Learning and Instruction
In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EduETH (ETH) and in the Institute for Educational Sciences (UZH).

Participants are exemplary introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.

Coping with Psychosocial Demands of Teaching (EW4)
This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

Abstract
This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

Objective
Any aspiring successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

Content
Thematische Schwerpunkte:
Lernen als Verhaltensänderung und als Informationsverarbeitung; Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen; Intelligenztheorien, Geschlechtsunterschiede beim Lernen

Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:
- Testentwicklung
- Gütekriterien von Tests
- Aufgabenkonstruktion
- Datenauswertung
- Rasch-Modell
- Internationale Vergleichstests
- Zulassungstests

Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören auch die Handouts der verschiedenen, studentischen Vorträge.

Als Grundlagenliteratur werden folgende Werke empfohlen:
- Weitere Literatur wird in der Lehrveranstaltung genannt.

Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen:
- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)
- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung
- Referat (RE)
- Schreiben einer schriftlichen Arbeit

Weitere Angaben zu den Leistungsanforderungen werden im Rahmen der Startveranstaltung abgegeben und erläutert.

Colloquium on the Science of Learning and Instruction
In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EduETH (ETH) and in the Institute for Educational Sciences (UZH).

Participants are exemplary introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.
851-0242-05L  
**Cognitively Activating Instructions in MINT Subjects**  
W 2 credits 2S  R. Schumacher  
*Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).*  
*This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".*  
*Abstract*  
The focus will be on the book “Intelligenz: Grosse Unterschiede und ihre Folgen” by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

851-0242-07L  
**Human Intelligence**  
W 1 credit 1S  E. Stern, P. Edelsbrunner, B. Rütsche  
*Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).*  
*Abstract*  
The focus will be on the book “Intelligenz: Grosse Unterschiede und ihre Folgen” by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

851-0242-08L  
**Research Methods in Educational Science**  
W 1 credit 1S  P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler  
*Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).*  
*Abstract*  
Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

**Subject Didactics and Professional Training**

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>402-0910-00L</td>
<td>Physics Didactics I: Special Didactics of Physics Teaching</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>M. Mohr</td>
</tr>
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</table>

Further information is available from the lecturer via email: mamohr@ethz.ch

Simultaneous enrolment in Introductory Internship Physics  
- course 402-0920-00L - is compulsory for Teaching Diploma Physic

Information for UZH students:  
Enrolment to this course unit only possible at ETH. No enrolment to module 090Phy1 at UZH.  
Please mind the ETH enrolment deadlines for UZH students: https://www.ethz.ch/en/studies/non-degree-courses/special-students/special-students-university-of-zurich.html

Objective  
Die Studierenden verfügen über fachdidaktisches Grundwissen für den Physikunterricht an einer Mittelschule. Sie können eigene Lektionen unter Berücksichtigung der vielfältigen Rahmenbedingungen planen, durchführen und evaluieren. Sie reflektieren ihren Unterricht und sind bestrebt, ihn didaktisch und pädagogisch weiter zu entwickeln.  
Die Studierenden kennen die Einsatzmöglichkeiten, Chancen und Schwierigkeiten verschiedener Unterrichtsmethoden und Hilfsmittel. Sie können die Eignung von Unterrichtsformen im Hinblick auf eine Lernsituation beurteilen. Sie bemühen sich in ihrem Unterricht, geeignete Methoden und Medien angepasst an die Klasse und das Thema einzusetzen.  
Thema: Themen im Unterricht

Lektionenplanung und Durchführung: Lehrplan, Unterrichtsplan, Zeitplan, Artikulationsschema, Berücksichtigung von Vorwissen, Übungen und Hausaufgaben, Prüfungen und Noten, Verständlichkeit von Lehrtexten, Weiterbildung, Unterrichtsevaluation

Fachspezifisches: Sachstruktur der gängigen Unterrichtsthemen, Alltagsbezüge, Fehlvorstellungen, Demonstrations- und Schülerexperimente, Arbeitsteilung zu physikalischen Themen des Grundlagen- und Schwerpunktsunterrichts

Einsatz verschiedener Unterrichtsmaterialien: Experimente, Computer, Taschenrechner, Video, Simulation

Unterrichtsformen: Lerngruppe, Werkstatt, Puzzle, Projekt, Gruppenarbeit, Praktikum

Lernformen

Interaktive Lehr-Lernveranstaltungen mit Vorträgen und Demonstrationen des Dozenten, studentischer Einzel- und Kleingruppenarbeit, kurzen Präsentationen der Studierenden, Verfeinerung der Inhalte durch Bearbeitung von Aufträgen ausserhalb der Kontaktstunden

Folien und weitere Unterlagen werden zur Verfügung gestellt

Die Veranstaltung wird während der Veranstaltung mitgeteilt

Die Veranstaltung ist zusammen mit dem Einführungspraktikum zu belegen

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**402-0915-00L Teaching Internship Including Examination Lessons**

**Abstract**

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

**Objective**


Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäß Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

**Content**

- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

**Methods**

With the help of the mentor the students individually work on a topic and write a thesis about it.

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**402-0737-00L Energy and Environment in the 21st Century (Part I)**

**Abstract**

The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

**Objective**

Scientists, especially physicists, are often confronted with questions related to the problems of energy and the environment.

The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.

The lecture is for students which are interested participate in a rational and responsible debate about the energy problem of the 21st century.
Content

Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human need/use?

Energy conservation and the first and second law of thermodynamics

Fossil fuels (our stored energy resources) and their use.

Burning fossil fuels and the physics of the greenhouse effect.

Physics basics of nuclear fission and fusion energy

Controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.

Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.

The problems with nuclear fusion and the ITER project.

Nuclear fission and fusion: "exotic" ideas.

Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.

New clean renewable energy sources and their physical limits (wind, solar, geothermal etc).

Energy perspectives for the next 100 years and some final remarks

Lecture notes

Many more details (in English and German) here:

http://hp.lx2.ethz.ch/energy21/

Literature


Environmental Physics: Boeker and Egbert New York Wiley 1999

Prerequisites / notice

Science promised us truth, or at least a knowledge of such relations as our intelligence can seize: it never promised us peace or happiness

Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don’t like a theory is not the essential question. Rather, it’s whether or not the theory gives predictions that agree with experiment.

Richard Feynman, 1985

402-0922-00L Mentored Work Specialised Courses in Physics with an Educational Focus A

Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Physics for TC and Teaching Diploma.

Abstract

In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective

Practice in the explanation of complex topics in physics as the core competence of the teaching profession

Content

Improvement of the physics education by providing attractive recent topics with regard to future curricular decisions and the public view of physics

402-0944-00L Science in School (Current Topics for the Classroom)

Enrolment in Physics Didactics I (402-0910-00L) and Physics Didactics II (402-0910-00L) is mandatory.

Content

Kennenlernen und erarbeiten (Übungen) von Unterrichtssequenzen zu modernen Themen der Physik.

Lecture notes

Unterlagen werden verteilt.

Literature

Wird angegeben.

Prerequisites / notice


Physics TC - Key for Type

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<th>Type</th>
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<th>Key</th>
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<td>Recommended, not eligible for credits</td>
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<td>Eligible for credits and recommended</td>
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<td>Courses outside the curriculum</td>
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ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Physics Teaching Diploma

Detailed information on the programme at: www.didaktischeausbildung.ethz.ch

## Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

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<td>R. Schumacher</td>
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<td>851-0242-07L</td>
<td>Human Intelligence Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
<td>1 credit</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport). Number of participants limited to 30. This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
<td></td>
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<tr>
<td>851-0242-09L</td>
<td>Student Research Projects: Practical Research on Learning and Instruction Number of participants limited to 20.</td>
<td>2 credits</td>
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<td>A. Deiglmayr, P. Edelsbrunner, S. Hofer, B. Rütsche, L. Schalk, E. Stern, E. Ziegler</td>
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</table>

### Objective

- Get to know cognitive activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

### Prerequisites / notice

Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

### Literature from the learning sciences is critically discussed with a focus on research methods.

## Subject Didactics in Physics

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>402-0910-00L</td>
<td>Physics Didactics I: Special Didactics of Physics Teaching Limited number of participants. Further information is available from the lecturer via email:</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Mohr</td>
<td></td>
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</tbody>
</table>

## Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

Abstract

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective

- Get to know cognitive activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites / notice

Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

Further information is available from the lecturer via email.
### Objective
Die Studierenden verfügen über fachdidaktisches Grundwissen für den Physikunterricht an einer Mittelschule. Sie können eigene Lektionen unter Berücksichtigung der vielfältigen Rahmenbedingungen planen, durchführen und evaluieren. Sie reflektieren ihren Unterricht und sind bestrebt, ihn didaktisch und pädagogisch weiter zu entwickeln.

Die Studierenden kennen die Einsatzmöglichkeiten verschiedener Unterrichtsmethoden und Hilfsmittel. Sie können die Eignung von Unterrichtsformen im Hinblick auf eine Lernsituation beurteilen. Sie bemühren sich in ihrem Unterricht, geeignete Methoden und Medien angepasst an die Klasse und das Thema einzusetzen.


### Content
- **Thematische Schwerpunkte**
  - Fachspezifisches: Sachstrukturen der gängigen Unterrichtsthemen, Alltagsbezüge, Fehlvorstellungen, Demonstrations- und Schülerexperimente, Arbeitsmittel zu physikalischen Themen des Grundlagen- und Schwerpunktunterrichts
  - Einsatz verschiedener Unterrichtsmaterialien: Experimente, Computer, Taschenrechner, Video, Simulation
  - Unterrichtsformen: Lernaufgabe, Werkstatt, Puzzle, Projekt, Gruppenarbeit, Praktikum
  - Lernformen
  - Interaktive Lehr-Lerneranlassung mit Vorträgen und Demonstrationen des Dozenten, studentischer Einzel- und Kleingruppenarbeit, kurzen Präsentationen der Studierenden, Verpflichtung der Inhalte durch Bearbeitung von Aufträgen ausserhalb der Kontaktstunden

### Lecture notes
- Folien und weitere Unterlagen werden zur Verfügung gestellt
- Die Veranstaltung ist zusammen mit dem Einführungspraktikum zu belegen

### Literature
- wird während der Veranstaltung mitgeteilt

### Prerequisites / notice
- Die Veranstaltung ist zusammen mit dem Einführungspraktikum zu belegen

### 402-0917-00L Mentored Work Subject Didactics Physics A

**Objective**
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**
The topics of the mentored work are mostly chosen from the high school curriculum.

**Methods**
With the help of the mentor the students individually work on a topic and write a thesis about it.

### 402-0918-00L Mentored Work Subject Didactics Physics B

**Objective**
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**
The topics of the mentored work are mostly chosen from the high school curriculum.

**Methods**
With the help of the mentor the students individually work on a topic and write a thesis about it.

### Professional Training in Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0920-00L</td>
<td>Introductory Internship Physics - course 402-0920-00L - is compulsory.</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>M. Mohr</td>
</tr>
</tbody>
</table>

**Abstract**
During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.
Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.

Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.

Students can assess the significance of subject topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils.

They develop the skills of the teaching trade.

They evaluate the balance between instruction, the openness and how pupils can, indeed, make their own cognitive contributions.

They learn to assess pupils' work.

Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

The Teaching Internship Physics is a supplement to the Teaching Internship required to obtain a Master of Advanced Studies in Secondary and Higher Education in the subject Physics as Major Subject.

The teaching practice is conducted in the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

The teaching practice is conducted in the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

Together with the teacher in charge of their teacher training, the students conduct regular preparatory meetings and final discussions. The students evaluate their own performance.

They learn to assess pupils' work.

They develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.

They analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Together with the teacher in charge of their teacher training, the students evaluate their own performance.

They learn to assess pupils' work.

They develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.

They analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

The Teaching Internship Physics is a supplement to the Teaching Internship required to obtain a Master of Advanced Studies in Secondary and Higher Education in the subject Physics as Major Subject.

The teaching practice is conducted in the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

Together with the teacher in charge of their teacher training, the students conduct regular preparatory meetings and final discussions. The students evaluate their own performance.

They learn to assess pupils' work.

They develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.

They analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.


### Lecture notes


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*Students who entered the teaching diploma in the spring semester 2014 or later have to pass the Internship in Physics Didactics. All other courses in this area can be chosen individually.*

*Students who entered the teaching diploma before the spring semester 2014 have to do either a Mentored Work or the Internship in Physics Didactics. Of course it is also possible to complete and count both units for the teaching diploma.*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0737-00L</td>
<td>Energy and Environment in the 21st Century (Part I)</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>M. Dittmar</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Scientists and espially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.</td>
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</table>
| **Content** | Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human needs/uses?  
Fossil fuels (our stored energy resources) and their use.  
Burning fossil fuels and the physics of the greenhouse effect.  
physics basics of nuclear fission and fusion energy  
controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.  
Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.  
The problems with nuclear fusion and the ITER project.  
Nuclear fusion and fission: "exotic" ideas.  
Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.  
new clean renewable energy sources and their physical limits (wind, solar, geothermal etc)  
Energy perspectives for the next 100 years and some final remarks |

| Lecture notes | many more details (in english and german) here:  
http://ihp-lx2.ethz.ch/energy21/  
Environmental Physics: Boeker and Egbert New York Wiley 1999 |

| **Literature** | Science promised us truth, or at least a knowledge of such relations as our intelligence can seize: if never promised us peace or happiness  
Gustave Le Bon  
Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question. Rather, it's whether or not the theory gives predictions that agree with experiment.  
Richard Feynman, 1985 |

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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0944-00L</td>
<td>Science in School (Current Topics for the Classroom)</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>C. Wagner, A. Vaterlaus</td>
</tr>
<tr>
<td><strong>Content</strong></td>
<td>Enrolment in Physics Didactics I (402-0910-00L) and Physics Didactics II (402-0910-00L) is mandatory.</td>
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</tr>
</tbody>
</table>
| **Lecture notes** | Kennenlernen und erarbeiten (Übungen) von Unterrichtsssequenzen zu modernen Themen der Physik.  
Unterlagen werden verteilt.  
Wird angegeben.  
402-0922-00L  Mentored Work Specialised Courses in Physics with an Educational Focus A  
Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Physics for TC and Teaching Diploma.

Abstract
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective
Practice in the explanation of complex topics in physics as the core competence of the teaching profession

Content
Choice of topic by individual arrangement

402-0923-00L  Mentored Work Specialised Courses in Physics with an Educational Focus B  
Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Physics for Teaching Diploma and for students upgrading TC to Teaching Diploma.

Abstract
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective
Practice in the explanation of complex topics in physics as the core competence of the teaching profession

Content
Choice of topic by individual arrangement

402-0924-00L  Internship Physics Didactics  
Internship Physics Didactics for Teaching Diploma with Physics as First Subject.


Abstract
During the Internship Physics Didactics students teach 8 lessons in the classes of an internship teaching person. Students develop, test and analyze teaching arrangement under the guidance of a mentor (one of the lecturers).

Objective
Basic knowledge for the design of teaching arrangements is the topic of the Physics Didactics I and II courses. In the subsequent Internship Physics Didactics students combine the theoretical knowledge acquired in the didactics courses with practical aspects of teaching. During the internship students learn to transform their teaching goals into a real live class room setting considering subject specific, didactical and pedagogical aspects.

Content

Lecture notes
Wird vom Mentor bestimmt.

Prerequisites /
notice
Das Fachdidaktikpraktikum kann erst nach dem Besuch der FD1 und frühestens mit der FD2 durchgeführt werden (eine gleichzeitige Belegung von Fachdidaktik 2 und Fachdidaktikpraktikum ist möglich).

Compulsory Elective Courses
Further course offerings from the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

Number  Title  Type  ECTS  Hours  Lecturers
402-0737-00L  Energy and Environment in the 21st Century (Part I)  W  6 credits  2V+1U  M. Dittmar

Abstract
The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

Objective
Scientists and espially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.

The lecture is for students which are interested participate in a rational and responsible debate about the enegryproblem of the 21. century.
Content

Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human needs/uses?

Energy conservation and the first and second law of thermodynamics

Fossil fuels (our stored energy resources) and their use.

Burning fossil fuels and the physics of the greenhouse effect.

Physics basics of nuclear fission and fusion energy

controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.

Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.

The problems with nuclear fusion and the ITER project.

Nuclear fusion and fission: "exotic" ideas.

Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.

new clean renewable energy sources and their physical limits (wind, solar, geothermal etc)

Energy perspectives for the next 100 years and some final remarks

Lecture notes

many more details (in english and german) here:

http://ihp-lx2.ethz.ch/energy21/

Literature


Environmental Physics: Boeker and Egbert New York Wiley 1999

Prerequisites / notice

Science promised us truth, or at least a knowledge of such relations as our intelligence can seize:
it never promised us peace or happiness

Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question.

Rather, it's whether or not the theory gives predictions that agree with experiment.

Richard Feynman, 1985

402-0944-00L

Science in School (Current Topics for the Classroom) W 2 credits 2G C. Wagner, A. Vaterlaus

Enrolment in Physics Didactics I (402-0910-00L) and Physics Didactics II (402-0910-00L) is mandatory.

Content

Kennenlernen und erarbeiten (Übungen) von Unterrichtsssequenzen zu modernen Themen der Physik.

Lecture notes

Unterlagen werden verteilt.

Literature

Wird angegeben.

Prerequisites / notice


252-0855-00L

Computer Science in Secondary School Mathematics W 4 credits 3G J. Hromkovic, G. Serafini

Abstract

The unit "Computer Science in Secondary School Mathematics" addresses key contributions of computer science to general education, the tight relations between the algorithmic and the mathematical way of thinking, and the thoughtful choice of computer science topics for high school mathematics classes.

Objective

The general goal of the course consists in presenting ways to teach fundamentals of computer science, which are closely related to contents and methods of mathematics. After attending the course unit, a mathematics teacher is able to teach selected fundamentals of computer science in mathematics classes.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.
The main topics of the course unit "Computer Science in Secondary School Mathematics" represent a scientific and didactic added value for mathematics classes.

The course covers the didactics of logic, of cryptology, of finite state automata, of computability and of the introduction to programming. The students develop the understanding of fundamental scientific concepts such as algorithm, program, complexity, determinism, computation, automata, verification, testing, security of a cryptosystem and secure communication. They reflect on ways to embed them into a scientifically sound and didactically sustainable mathematics course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

Lecture notes
Literature

see Compulsory Elective Courses Teaching Diploma

Physics Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>E-</th>
<th>Z</th>
<th>Dr</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>Recommended, not eligible for credits</td>
<td>Courses outside the curriculum</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>P</th>
<th>A</th>
<th>D</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>practical/laboratory course</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>independent project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Core Courses

One Core Course in Experimental or Theoretical Physics from Physics Bachelor is eligible; however, this Core Course from Physics Bachelor cannot be used to compensate for the mandatory Core Course in Experimental or Theoretical Physics.
For the category assignment keep the choice “no category” and take contact with the Study Administration (www.phys.ethz.ch/studies/study-administration.html) after having received the credits.

Core Courses in Theoretical Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0861-00L</td>
<td>Statistical Physics</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>G. Blatter</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture covers the concepts of classical and quantum statistical physics, and some aspects of kinetic gas theory and hydrodynamics. In a more advanced part degenerate Fermions, Bose-Einstein condensation, real Bose gases, magnetism, general mean field theory and critical phenomena will be addressed.</td>
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<tr>
<td>Objective</td>
<td>This lecture gives an introduction in the basic concepts and applications of statistical physics for the general use in physics and, in particular, as a preparation for the theoretical solid state physics education.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes available in german.</td>
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</tr>
<tr>
<td>Literature</td>
<td>No specific book is used for the course. Relevant literature will be given in the course.</td>
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</thead>
<tbody>
<tr>
<td>402-0843-00L</td>
<td>Quantum Field Theory I</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>C. Anastasiou</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and special relativity. Topics include: - Relativistic quantum mechanics - Quantisation of bosonic and fermionic fields - Interactions in perturbation theory - Scattering processes and decays - Radiative corrections</td>
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</tr>
<tr>
<td>Objective</td>
<td>The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.</td>
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</tr>
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<td>Literature</td>
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</thead>
<tbody>
<tr>
<td>402-0830-00L</td>
<td>General Relativity</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>P. Jetzer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Manifold, Riemannian metric, connection, curvature; Special Relativity; Lorentzian metric; Equivalence principle; Tidal force and spacetime curvature; Energy-momentum tensor, field equations, Newtonian limit; Post-Newtonian approximation; Schwarzschild solution; Mercury’s perihelion precession, light deflection.</td>
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<tr>
<td>Objective</td>
<td>Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.</td>
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</table>

Core Courses: Experimental Physics

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<tr>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0257-00L</td>
<td>Advanced Solid State Physics</td>
<td>W</td>
<td>10 credits</td>
<td>3V+2U</td>
<td>A. Zheludev</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is an extension of the introductory course on solid state physics. The purpose of this course is to learn to navigate the complex collective quantum phases, excitations and phase transitions that are the dominant theme in modern solid state physics. The emphasis is on the main concepts and on specific experimental examples, both classic ones and those from recent research.</td>
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<tr>
<td>Objective</td>
<td>The goal is to study how novel phenomena emerge in the solid state.</td>
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</tr>
</tbody>
</table>
Today's challenges and opportunities in Solid State Physics

Phase transitions and critical phenomena
- Main concepts: coherence length, symmetry, order parameter, correlation functions, generalized susceptibility
- Bragg-Williams mean field theory
- Landau theory of phase transitions
- Fluctuations in Landau theory
- Critical exponents: significance, measurement, inequalities, equalities
- Scaling and hyperscaling
- Universality
- Critical dynamics
- Quantum phase transitions and quantum criticality

Fermi surface instabilities
- The concept of the Landau Fermi liquid in metals
- Kohn anomalies
- Charge density waves
- Metallic ferromagnets and half-metals
- Spin density waves

Magnetism of insulators
- Magnetic interactions in solids and the spin Hamiltonian
- Magnetic structures and phase transitions
- Spin waves
- Quantum magnetism

Electron correlations in solids
- Mott insulating state
- Phases of the Hubbard model
- Layered cuprates (non-superconducting properties)

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Lecture notes
The printed material for this course involves: (1) a self-contained script, distributed electronically at semester start. (2) Experimental examples (Power Point slide-style) selected from original publications, distributed at the start of every lecture.

Literature
A list of books will be distributed. Numerous references to useful published scientific papers will be provided.

Prerequisites / notice
This course is for students who like to be engaged in active learning. The "exercise classes" are organized in a non-traditional way: following the idea of "less is more", we will work on only about half a dozen topics, and this gives students a chance to take a look at original literature (provided), and to get the grasp of a topic from a broader perspective.

Students report back that this mode of "exercise class" is more satisfying than traditional modes, even if it does not mean less effort.

402-0442-00L Quantum Optics W 10 credits 3V+2U J. Faist

Abstract
This course gives an introduction to the fundamental concepts of Quantum Optics and will highlight state-of-the-art developments in this rapidly evolving discipline. The topics covered include the quantum nature of light, semi-classical and quantum mechanical description of light-matter interaction, laser manipulation of atoms and ions, optomechanics and quantum computation.

Objective
The course aims to provide the knowledge necessary for pursuing research in the field of Quantum Optics. Fundamental concepts and techniques of Quantum Optics will be linked to modern experimental research. During the course the students should acquire the capability to understand currently published research in the field.

Content
This course gives an introduction to the fundamental concepts of Quantum Optics and will highlight state-of-the-art developments in this rapidly evolving discipline. The topics that are covered include:
- coherence properties of light
- quantum nature of light: statistics and non-classical states of light
- light matter interaction: density matrix formalism and Bloch equations
- quantum description of light matter interaction: the Jaynes-Cummings model, photon blockade
- laser manipulation of atoms and ions: laser cooling and trapping, atom interferometry,
- further topics: Rydberg atoms, optomechanics, quantum computing, complex quantum systems.

Lecture notes
Selected book chapters will be distributed.

Literature
Text-books:
G. Grynberg, A. Aspect and C. Fabre, Introduction to Quantum Optics
R. Loudon, The Quantum Theory of Light
Atomic Physics, Christopher J. Foot
Advances in Atomic Physics, Claude Cohen-Tannoudji and David Guéry-Odelin
C. Cohen-Tannoudji et al., Atom-Photon-Interactions
M. Scully and M.S. Zubairy, Quantum Optics
Y. Yamamoto and A. Imamoglu, Mesoscopic Quantum Optics

402-0402-00L Ultrafast Laser Physics W 10 credits 3V+2U L. P. Gallmann, S. Johnson, U. Keller

Abstract
Introduction to ultrafast laser physics with an outlook into cutting edge research topics such as attosecond science and coherent ultrafast sources from THz to X-rays.

Objective
Understanding of basic physics and technology for pursuing research in ultrafast laser science. How are ultrashort laser pulses generated, how do they interact with matter, how can we measure these shortest man-made events and how can we use them to time-resolve ultrafast processes in nature? Fundamental concepts and techniques will be linked to a selection of hot topics in current research and applications.
The lecture covers the following topics:

a) Linear pulse propagation: mathematical description of pulses and their propagation in linear optical systems, effect of dispersion on ultrashort pulses, concepts of pulse carrier and envelope, time-bandwidth product

b) Dispersion compensation: technologies for controlling dispersion, pulse shaping, measurement of dispersion

c) Nonlinear pulse propagation: intensity-dependent refractive index (Kerr effect), self-phase modulation, nonlinear pulse compression, self-focusing, filamentation, nonlinear Schrödinger equation, solitons, non-instantaneous nonlinear effects (Raman/Brillouin), self-steepening, saturable gain and absorption

d) Second-order nonlinearities with ultrashort pulses: phase-matching with short pulses and real beams, quasi-phase matching, second-harmonic and sum-frequency generation, parametric amplification and generation

e) Relaxation oscillations: dynamical behavior of rate equations after perturbation

f) Q-switching: active Q-switching and its theory based on rate equations, active Q-switching technologies, passive Q-switching and theory

g) Active modelocking: introduction to modelocking, frequency comb versus axial modes, theory for various regimes of laser operation, Haus master equation formalism

h) Passive modelocking: slow, fast and ideally fast saturable absorbers, semiconductor saturable absorber mirror (SESAM), designs of and materials for SESAMs, modelocking with slow absorber and dynamic gain saturation, modelocking with ideally fast saturable absorber, Kerr-lens modelocking, soliton modelocking, Q-switching instabilities in modelocked lasers, inverse saturable absorption

i) Pulse duration measurements: rf cables and electronics, fast photodiodes, linear system theory for microwave test systems, intensity and interferometric autocorrelations and their limitations, frequency-resolved optical gating, spectral phase interferometry for direct electric-field reconstruction and more

j) Noise: microwave spectrum analyzer as laser diagnostics, amplitude noise and timing jitter of ultrafast lasers, lock-in detection

k) Ultrafast measurements: pump-probe scheme, transient absorption/differential transmission spectroscopy, four-wave mixing, optical gating and more

l) Frequency comb and carrier-envelope offset phase: measurement and stabilization of carrier-envelope offset phase (CEP), time and frequency domain applications of CEP-stabilized sources

m) High-harmonic generation and attosecond science: non-perturbative nonlinear optics / strong-field phenomena, high-harmonic generation (HHG), phase-matching in HHG, attosecond pulse generation, attosecond technology: detectors and diagnostics, attosecond metrology (streaking, RABBITT, transient absorption, attoclock), example experiments

n) Ultrafast THz science: generation and detection, physics in THz domain, weak-field and strong-field applications

o) Brief introduction to other hot topics: relativistic and ultra-high intensity ultrafast science, ultrafast electron sources, free-electron lasers, etc.

Prerequisites / notice
Prerequisites: Basic knowledge of quantum electronics (e.g., 402-0275-00L Quantenelektronik).
Abstract
The Course will treat the subjects of the crystal structure of bulk and surfaces, imaging surfaces with electrons and ions, general scanning probe microscopy methods, Scanning Tunnelling Microscopy, Atomic force microscopy, Electronic structure of the bulk and surfaces, Photoelectric emission, STM and AFM spectroscopy. The various techniques will be illustrated with examples from modern research.

Objective
It is the aim of this course to provide a review of modern aspects in surface science research.

Content
Course description
The course will start with an overview of the fundamentals of bulk crystals and a reminder on the x-ray diffraction from crystals. We will continue with the extension of the alphabet of bulk crystal structure to surfaces and the nomenclature of surface reconstructions and interesting structures like moiré patterns will be introduced. Following the two introductory weeks, we will dwell in to the realm of imaging the surfaces. We will start with electron beam based imaging and analysis techniques of surfaces. Scanning Electron Microscopy (SEM), Low Energy Electron Diffraction (LEED) and Low Energy Electron Microscopy (LEEM) will be discussed. Imaging with ion beam based techniques like Low Energy Ion Scattering (LEIS) and He-ion microscopy will be touched upon. Following these, probe microscopy techniques will be explored starting with the topografiner and continuing with Scanning Tunnelling Microscopy (STM), Basics of Atomic Force Microscopy (AFM) will follow. Imaging is a fundamental part of efforts on understanding surfaces. Yet, a thorough understanding and capability of generating and manipulating novel surface and interface systems can only be achieved by studying the electronic structure of surfaces. In order to investigate the electronic structure of surface and interface systems, a basic knowledge of the bulk electronic structure is necessary. So, introductory concepts on the electronic structure of the bulk and low dimensional systems will be discussed. Then, the basics of photoelectron emission from surfaces will be given. In the final two weeks of the course an overview of the spectroscopic modes of scanning probes and atomic scale electron spectroscopy will be introduced.

Course contents
1) Introduction and reminder of bulk crystals (week 1):
Reminder of the crystal structure, x-ray diffraction and determination of the crystal structure.

2) Crystal surfaces (weeks 2 and 3):
Definitions, description of surfaces, and reconstructions; Moire patterns; quasi-crystals.

3) Imaging surfaces with electrons (week 4):
SEM, LEED, LEEM

4) Imaging surfaces with ions (week 5):
LEIS, He ion microscopy

5) Introduction to probe microscopy (week 6):
General problems, field ion microscope, topografiner

6) Scanning Tunnelling Microscopy (weeks 6, 7 and 8):
Tunnelling problem (reminder), work function derivation and measurement with STM, imaging surfaces in real space, surface reconstructions, examples from metals and semiconductors and hybrid surface systems

7) Atomic force microscopy (week 9):
Technique, basics, examples.

8) Electronic structure of the bulk (week 10):
Reminders: density of states, band structure, low dimensional systems

9) Electronic structure of surfaces (week 11):
Bulk derived states, image states, examples from STM research

10) Photoelectric emission (week 12):
Basics of spectroscopy with x-rays and electrons.

11) STM and AFM derived spectroscopy techniques (weeks 13 and 14):
Comparative studies of Scanning Tunnelling spectroscopy (STS) to other integral spectroscopic methods.

Literature
6) Charles Kittel, Introduction to Solid State Physics (8th Ed.)
7) Neil W. Ashcroft and N. David Mermin, Solid State Physics
8) Harald Ibach and Hans Lüth, Solid-State Physics: An Introduction to Principles of Materials Science
9) Further reading material will be supplied.

Prerequisites / notice
At least, 4 homework will be assigned.

402-0526-00L Ultrafast Processes in Solids

Abstract
Ultrafast processes in solids are of fundamental interest as well as relevant for modern technological applications. The dynamics of the lattice, the electron gas as well as the spin system of a solid are discussed. The focus is on time resolved experiments which provide insight into pico- and femtosecond dynamics.

Objective
After attending this course you understand the dynamics of essential excitation processes which occur in solids and you have an overview over state of the art experimental techniques used to study fast processes.
1. Introduction and overview

At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures:

- Laser induced ultrafast demagnetization
- Ultrafast spin currents generated by lasers
- Landau-Lifshitz-Dynamics
- Laser induced switching

2. Dynamics of the electron gas

2.1 First experiments on electron dynamics and lattice heating
2.2 The finite lifetime of excited states
2.3 Detection of lifetime effects
2.4 Dynamical properties of reactions and adsorbents

3. Dynamics of the lattice

3.1 Phonons
3.2 Non-thermal melting

4. Dynamics of the spin system

4.1 Laser induced ultrafast demagnetization
4.2 Ultrafast spin currents generated by lasers
4.3 Landau-Lifshitz-Dynamics
4.4 Laser induced switching

5. Correlated materials

Relevant publications will be cited

This course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, atomic paramagnetism and diamagnetism, itinerant and local-moment magnetism, Ising and Heisenberg models, the mean-field approximation, spin waves, magnetic phase transition, domains and domain walls, magnetization dynamics from picoseconds to human time scales.

Preliminary contents for the HS16:
- Magnetism in atoms (quantum-mechanical origin of atomic magnetic moments, intra-atomic exchange interaction)
- Magnetism in solids (mechanisms producing inter-atomic exchange interaction in solids, crystal field).
- Magnetic order at finite temperatures (Ising and Heisenberg models, mean-field approximation, low-dimensional magnetism)
- Dipolar interaction in ferromagnets (shape anisotropy, frustration and modulated phases of magnetic domains)
- Spin physics in the time domain (Larmor precession, resonance phenomena, Bloch equation, Landau-Lifshitz-Gilbert equation, superparamagnetism)

The course gives an introduction to the use of synchrotron radiation in materials science. It covers the generation of intense x-ray beams at synchrotron radiation sources and their use for the characterisation of materials properties at different length scales. As part of the course, experiments will be carried out at the Swiss Light Source, Paul Scherrer Institut.

Lecture notes will be distributed

The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, atomic paramagnetism and diamagnetism, itinerant and local-moment magnetism, Ising and Heisenberg models, the mean-field approximation, spin waves, magnetic phase transition, domains and domain walls, magnetization dynamics from picoseconds to human time scales.

The course is taught in English.

The former title of this course unit was "Fundamental Aspects of Magnetism". This lecture insists on the fundamental aspects -- quantum and statistical physics of magnetism -- which are often not comprehensively spelled out in conventional lectures on solid state physics.

The lecture notes and slides are made available during the course, through the Moodle portal.

Applications to nanoscale magnetism will be considered from the perspective of basic underlying principles.

The course gives an introduction to the use of synchrotron radiation in materials science. It treats the generation of intense x-ray beams at synchrotron radiation sources and their use for the characterisation of materials properties at different length scales. As part of the course, experiments will be carried out at the Swiss Light Source, Paul Scherrer Institut.

Lecture notes will be distributed

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Lecture notes will be distributed

The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, atomic paramagnetism and diamagnetism, itinerant and local-moment magnetism, Ising and Heisenberg models, the mean-field approximation, spin waves, magnetic phase transition, domains and domain walls, magnetization dynamics from picoseconds to human time scales.

The course is taught in English.

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The lecture notes and slides are made available during the course, through the Moodle portal.

Applications to nanoscale magnetism will be considered from the perspective of basic underlying principles.
Semiconductor Materials: Fundamentals and Fabrication

Topics to be discussed in the class include:

- Semiconductor Materials: Fundamentals and Fabrication
- Terahertz frequency electromagnetic radiation lies at the border between electronics and optics, and as such has many unique properties
- Basic knowledge of semiconductor physics and technology. Application of this knowledge for state-of-the-art semiconductor device processing
- The rich physics of the optical properties of semiconductors, as well as the advanced processing available on these materials, enabled demand systems for a pretty reasonable price.

### Prerequisites / Literature

The course will be designed by J. Als-Nielsen in collaboration with staff from the SLS.

- The lab course has been designed by J. Als-Nielsen and D. McMorrow: Elements of Modern X-Ray Physics, Wiley, 2011.
- Principles of Terahertz Science and Technology, Yun-Shick Lee (Springer, 2008).
- The former course title of this course is "Terahertz Technology and Applications".
- New methods: Coherent x-ray scattering and diffractive imaging.

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<thead>
<tr>
<th>Number</th>
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<td>402-0317-00L</td>
<td>Semiconductor Materials: Fundamentals and Fabrication</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>S. Schön. W. Wegscheider</td>
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<tr>
<td>402-0464-00L</td>
<td>Optical Properties of Semiconductors</td>
<td>W</td>
<td>8</td>
<td>2V+2U</td>
<td>A. Imamoglu, G. Scalari</td>
</tr>
<tr>
<td>402-0865-66L</td>
<td>Physics of Cold Atomic Gases</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>W. Zwerger</td>
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</table>

### Selection: Quantum Electronics

#### Prerequisites / notice

- Part of the course is in the form of practical work at the Swiss Light Source. During two days (dates to be agreed), the following experiments will be performed: (1) elastic and Compton scattering, (2) liquid scattering and powder diffraction, and (3) X-ray absorption spectroscopy.

#### Abstract

This course presents a comprehensive discussion of optical processes in semiconductors.

#### Objective

Basic knowledge of semiconductor physics and technology. Application of this knowledge for state-of-the-art semiconductor device processing

#### Content

Fundamentals of Solid State Physics: Semiconductor materials, band structures, carrier statistics in intrinsic and doped semiconductors, p-n junctions, low-dimensional structures; Bulk growth of Semiconductors: CZochralski method, floating zone method, high-pressure synthesis; Semiconductor Epitaxy: Fundamentals, MBE, MOCVD, LPE; In situ characterization: RHEED, LEED, AES, XPS, process control (temperature, thickness)

#### Literature

- A reader and a guide through the experiments at the Swiss Light Source will be available on the web.

### Selection: Particle Physics, Nuclear Physics

#### Prerequisites / notice

- The readings for the course will draw mostly on current journal articles that will be distributed in class/via moodle. There is also a general textbook listed below available electronically via the ETH library system. You can also order a black-and-white paperback via an "on-demand" system for a pretty reasonable price.

#### Abstract

This course presents a comprehensive discussion of optical processes in semiconductors.

#### Objective

Basic knowledge of semiconductor physics and technology. Application of this knowledge for state-of-the-art semiconductor device processing

#### Content

- Fundamentals of Solid State Physics: Semiconductor materials, band structures, carrier statistics in intrinsic and doped semiconductors, p-n junctions, low-dimensional structures; Bulk growth of Semiconductors: CZochralski method, floating zone method, high-pressure synthesis; Semiconductor Epitaxy: Fundamentals, MBE, MOCVD, LPE; In situ characterization: RHEED, LEED, AES, XPS, process control (temperature, thickness)

#### Literature

- Principles of Terahertz Science and Technology, Yun-Shick Lee (Springer, 2008).
- New methods: Coherent x-ray scattering and diffractive imaging.

#### Prerequisites / notice

- The former course title of this course is "Terahertz Technology and Applications".

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**Data:** 06.11.2018 12:57  **Autumn Semester 2016**  **Page 1252 of 1571**
**ECTS Lecturers**

Successful students know:

3V+1U

The course aims to provide an introduction to selected advanced topics in low energy particle physics with neutrons and muons.

1. Examples of modern experiments
2. Basics: Bethe-Bloch, radiation length, nucl. interaction length, fixed-target vs. collider, principles of measurements: energy- and momentum-conservation, etc
3. Physics and layout of accelerators
4. Charged particle tracking and vertexing
5. Calorimetry
6. Particle identification
7. Analysis methods: invariant and missing mass, jet algorithms, b-tagging
8. Special detectors: extended airshower detectors and cryogenic detectors
9. MC simulations (GEANT), trigger, readout, electronics

Objective

Acquire an in-depth understanding and overview of the essential elements of experimental methods in particle physics, including accelerators and experiments.

Content

1. Examples of modern experiments
2. Basics: Bethe-Bloch, radiation length, nucl. interaction length, fixed-target vs. collider, principles of measurements: energy- and momentum-conservation, etc
3. Physics and layout of accelerators
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6. Particle identification
7. Analysis methods: invariant and missing mass, jet algorithms, b-tagging
8. Special detectors: extended airshower detectors and cryogenic detectors
9. MC simulations (GEANT), trigger, readout, electronics

Lecture notes

Slides are handed out regularly, see http://www.physik.uzh.ch/en/teaching/PHY461/HS2016.html

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<th>Number</th>
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<td>Experimental Methods and Instruments of Particle Physics</td>
<td>W</td>
<td>6 credits</td>
<td>3V+1U</td>
<td>U. Langenegger, M. Dittmar, A. Streun, University lecturers</td>
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<td>Abstract</td>
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<td></td>
<td>Physics and design of particle accelerators.</td>
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<td>Basics and concepts of particle detectors.</td>
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<td>Track- and vertex-detectors, calorimetry, particle identification.</td>
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<td>Special applications like Cherenkov detectors, air showers, direct detection of dark matter.</td>
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<td>Simulation methods, readout electronics, trigger and data acquisition.</td>
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<td>Examples of key experiments.</td>
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<td>Acquire an in-depth understanding and overview of the essential elements of experimental methods in particle physics, including accelerators and experiments.</td>
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<td>1. Examples of modern experiments</td>
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<td>2. Basics: Bethe-Bloch, radiation length, nucl. interaction length, fixed-target vs. collider, principles of measurements: energy- and momentum-conservation, etc</td>
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<td>6. Particle identification</td>
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<td>7. Analysis methods: invariant and missing mass, jet algorithms, b-tagging</td>
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<td>8. Special detectors: extended airshower detectors and cryogenic detectors</td>
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<td>9. MC simulations (GEANT), trigger, readout, electronics</td>
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<td>Lecture notes</td>
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<td>Slides are handed out regularly, see <a href="http://www.physik.uzh.ch/en/teaching/PHY461/HS2016.html">http://www.physik.uzh.ch/en/teaching/PHY461/HS2016.html</a></td>
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<td>402-0713-00L</td>
<td>Astro-Particle Physics I</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>A. Biland</td>
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<td>Abstract</td>
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<td>This lecture gives an overview of the present research in the field of Astro-Particle Physics, including the different experimental techniques. In the first semester, main topics are the charged cosmic rays including the antimatter problem. The second semester focuses on the neutral components of the cosmic rays as well as on some aspects of Dark Matter.</td>
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<td>Successful students know:</td>
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<td>- experimental methods to measure cosmic ray particles over full energy range</td>
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<td>- current knowledge about the composition of cosmic ray</td>
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<td>- possible cosmic acceleration mechanisms</td>
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<td>- correlation between astronomical object classes and cosmic accelerators</td>
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<td>- information about our galaxy and cosmology gained from observations of cosmic ray</td>
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<td>- definition of Astro-Particle Physics</td>
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<td>- important historical experiments</td>
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<td>- chemical composition of the cosmic rays</td>
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<td>- direct observations of cosmic rays</td>
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<td>- 'extended air showers' and 'cosmic muons'</td>
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<td>- 'knee' and 'ankle' in the energy spectrum</td>
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<td>- the 'anti-matter problem' and the Big Bang</td>
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<td>- 'cosmic accelerators'</td>
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<td>Lecture notes</td>
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<td>See lecture home page: <a href="http://ihp-lx2.ethz.ch/AstroTeilchen/">http://ihp-lx2.ethz.ch/AstroTeilchen/</a></td>
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<td>Particle Physics in the Early Universe</td>
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<td>6 credits</td>
<td>2V+1U</td>
<td>A. Biland</td>
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<td>Abstract</td>
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<td>An introduction to key concepts on the interface of Particle Physics and Early Universe cosmology. Topics include inflation and inflationary models, the ElectroWeak phase transition and vacuum stability, matter-antimatter asymmetry, recombination and the Cosmic Microwave Background, relic abundances and primordial nucleosynthesis, baryogenesis, dark matter and more.</td>
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<td>Prerequisites / notice</td>
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<td>Prerequisites: Particle Physics Phenomenology 1 or Quantum Field Theory 1</td>
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<td>Recommended: Quantum Field Theory 2, Advanced Field Theory, General Relativity</td>
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<td>402-0715-00L</td>
<td>Low Energy Particle Physics</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>A. S. Antognini, P. A. Schmidt-Weilenburg</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Low energy particle physics provides complementary information to high energy physics with colliders. In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today.</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>The course aims to provide an introduction to selected advanced topics in low energy particle physics with neutrons and muons.</td>
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<td>Content</td>
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<td>Low energy particle physics provides complementary information to high energy physics with colliders. At the Large Hadron Collider one directly searches for new particles at energies up to the TeV range. In a complementary way, low energy particle physics indirectly probes the existence of such particles and provides constraints for &quot;new physics&quot;, making use of precision and high intensities.</td>
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<td>Besides the sensitivity to effects related with new physics (e.g. lepton flavor violation, symmetry violations, CPT tests, search for electric dipole moments, new low mass exchange bosons etc.), low energy physics provides the best test of QED (electron g-2), the best tests of bound-state QED (atomic physics and exotic atoms), precise determinations of fundamental constants, information about the CKM matrix, precise information on the weak and strong force even in the non-perturbative regime etc.</td>
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<td>In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today. Starting from a general introduction on high intensity/high precision particle physics and the main characteristics of muons and neutrons and their production, we will then focus on the discussion of fundamental problems and ground-breaking experiments:</td>
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<td>- Production and characteristics of muon and neutron beams</td>
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<td>- Ultracold neutron production</td>
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<td>- Measurement of the neutron lifetime and electric dipole moment</td>
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<td>- The neutron in the gravitational field and its electric charge</td>
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<td></td>
<td>- Muon and neutron decay correlations</td>
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<td></td>
<td>- Lepton flavour violations with muons to search for new physics</td>
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<td></td>
<td>- What atomic physics can do for particle physics and vice versa</td>
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<td></td>
<td>- Laser experiments at accelerators</td>
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<td>- From myonic hydrogen to the proton structure and bound-state QED</td>
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<td></td>
<td>- From pionic hydrogen to the strong interaction and effective field theories</td>
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<td></td>
<td>- etc.</td>
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</tbody>
</table>
### Literature
- Golub, Richardson & Lamoreaux: "Ultra-Cold Neutrons"
- Rauch & Werner: "Neutron Interferometry"
- Carlile & Willis: "Experimental Neutron Scattering"
- Byrne: "Neutrons, Nuclei and Matter"
- Klapdor-Kleingrothaus: "Non Accelerator Particle Physics"

### Prerequisites / notice
Einführung in die Kern- und Teilchenphysik / Introduction to Nuclear- and Particle-Physics

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### 402-0767-00L Neutrino Physics

<table>
<thead>
<tr>
<th>Abstract</th>
<th>Theoretical basis and selected experiments to determine the properties of neutrinos and their interactions (mass, spin, helicity, chirality, oscillations, interactions with leptons and quarks).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Introduction to the physics of neutrinos with special consideration of phenomena connected with neutrino masses.</td>
</tr>
</tbody>
</table>

### 402-0777-00L Particle Accelerator Physics and Modeling I

<table>
<thead>
<tr>
<th>Abstract</th>
<th>This is the first of two courses, introducing particle accelerators from a theoretical point of view and covers state-of-the-art modeling techniques. It emphasizes the multidisciplinary aspect of the field, both in methodology (numerical and computational methods) and with regard to applications such as medical, industrial, material research and particle physics.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>You understand the building blocks of particle accelerators. Modern analysis tools allows you to model state-of-the-art particle accelerators. In some of the exercises you will be confronted with next generation machines. We will develop a Python simulation tool (AccelEGOrator) that reflects the theory from the lecture.</td>
</tr>
</tbody>
</table>
| Content | - Particle Accelerators an Overview  
- Relativity for Accelerator Physicists  
- Building Blocks of Particle Accelerators  
- Lie Algebraic Structure of Classical Mechanics and Applications to Particle Accelerators  
- Symplectic Maps & Analysis of Maps  
- Particle Tracking  
- Linear & Circular Machines  
- Cyclotrons  
- Free Electron Lasers  
- Collective effects in linear approximation  
- Preview of Particle Accelerator Physics and Modeling II |
| Literature | Particle Accelerator Physics, H. Wiedemann, ISBN-13 978-3-540-49043-2, Springer |

### 402-0851-00L QCD: Theory and Experiment

<table>
<thead>
<tr>
<th>Abstract</th>
<th>An introduction to the theoretical aspects and experimental tests of QCD, with emphasis on perturbative QCD and related experiments at colliders.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Knowledge acquired on basics of perturbative QCD, both of theoretical and experimental nature. Ability to perform simple calculations of perturbative QCD, as well as to understand modern publications on theoretical and experimental aspects of perturbative QCD.</td>
</tr>
</tbody>
</table>
| Content | QCD Lagrangian and Feynman Rules  
QCD running coupling  
Parton model  
Albarelli-Parisi equations  
Basic processes  
Experimental tests at lepton and hadron colliders  
Measurements of the strong coupling constant |
2) R. K. Ellis, W. J. Stirling, B. R. Webber ; "QCD and Collider Physics" (Cambridge Monographs on Particle Physics, Nuclear Physics & Cosmology) |

### 402-0737-00L Energy and Environment in the 21st Century (Part I)

<table>
<thead>
<tr>
<th>Abstract</th>
<th>The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Scientists and especially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.</td>
</tr>
<tr>
<td>Notice</td>
<td>The lecture is for students which are interested participate in a rational and responsible debate about the energyproblem of the 21. century.</td>
</tr>
</tbody>
</table>
Content

Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human needs/uses?

Energy conservation and the first and second law of thermodynamics

Fossil fuels (our stored energy resources) and their use.

Burning fossil fuels and the physics of the greenhouse effect.

Physics basics of nuclear fission and fusion energy

Controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.

Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.

The problems with nuclear fusion and the ITER project.

Nuclear fusion and fission: ”exotic” ideas.

Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.

New clean renewable energy sources and their physical limits (wind, solar, geothermal etc)

Energy perspectives for the next 100 years and some final remarks

Lecture notes

many more details (in english and german) here:

http://ihp-lx2.ethz.ch/energy21/

Literature

Die Energiefrage - Bedarf und Potentiale, Nutzung, Risiken und Kosten:


Environmental Physics: Boeker and Egbert New York Wiley 1999

Prerequisites / notice

Science promised us truth, or at least a knowledge of such relations as our intelligence can seize:

it never promised us peace or happiness

Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question.

Rather, it's whether or not the theory gives predictions that agree with experiment.

Richard Feynman, 1985

Selection: Theoretical Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0822-13L</td>
<td>Introduction to Integrability</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>N. Beisert</td>
</tr>
<tr>
<td>402-0883-63L</td>
<td>Symmetries in Physics</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>M. Gaberdiel</td>
</tr>
<tr>
<td>402-0898-00L</td>
<td>The Physics of Electroweak Symmetry Breaking</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>not available</td>
</tr>
</tbody>
</table>
Introduction to Lattice QCD

To gain familiarity with the formalism of lattice field theories and their numerical simulation methods.


This course offers an introduction to quantum field theories, in particular QCD, formulated on a space-time lattice. The lattice provides a non-perturbative, gauge-invariant regularization scheme for the Euclidean path integral. The course introduces both the theoretical background and the computational tools, like Monte Carlo simulations, used for the quantitative study of quarks and gluons.

Topics:
- Introduction to Effective Field Theories
- The Apelquist-Carrazzone theorem
- The matching procedure
- Chiral Lagrangians
- The SM as an EFTs
- The SUSY algebra
- Superspace and superfields
- Supersymmetric field theories
- Supersymmetric gauge theories
- Supersymmetry breaking
- The Minimal supersymmetric Standard Model

M. Grazzini

Higgs Hunter's Guide

R. Renner

The course introduces the theory and phenomenology of the recently discovered Higgs boson. With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

**Experimental part:**
- reminders of multivariate techniques: Neural Networks, Decision Trees
- reminders of statistics: likelihoods, hypothesis testing
- reminders of detectors/accelerators
- main channels overview
- dissection on analyisis
- combine information from all channels
- differential measurements
- off-shell measurement
- Future:
  - pseudo-observables / EFT
  - Beyond Standard Model

**Literature**
- S. Dawson, J. Gunion, H. Haber and G. Kane

**Prerequisites / notice**
QFT-I (mandatory) and QFT-II (highly recommended).
A mechanical metamaterial derives its static or dynamic properties not from its microscopic composition but rather through its clever

Objective

The course gives an insight into the notion of information and its relevance to physics and, in particular, quantum mechanics. It also serves as a preparation for further courses in the area of quantum information sciences.

402-0811-00L Programming Techniques for Scientific Simulations I

Objective

This course provides an introduction to programming techniques for scientific simulations. The focus is on advanced C++ programming techniques and scientific software libraries. Based on an overview over the hardware components of PCs and supercomputers, optimization methods for scientific simulation codes are explained.

402-0809-00L Dissipation in Quantum Systems

Objective

The course will basically explore the question, "What are the effects of an external environment on the dynamics of a small system?" We will also briefly explore the notions of entanglement entropy and concurrence in such systems.

Content

Some of these questions are linked to more general questions of thermalization and relaxation of open quantum systems.

Prerequisites / notice

The preceding attendance of the scheduled lecture courses "Introduction to Solid State Physics" and "Quantum Mechanics I" are mandatory. The courses "Quantum Mechanics II" and "Solid State Theory" provide the most optimal conditions to follow the course.

402-0865-66L Physics of Cold Atomic Gases

Objective

The students should get acquainted with a modern toolbox in the design of mechanical metamaterials. Equipped with the knowledge of the key design principles, the students will be able to choose the appropriate approach to create a metamaterial with a pre-defined functionality either for dynamic applications such as vibration isolation, wave-guiding, or the design of a heat-diode, or static properties such as stress absorption or the design of mechanisms used in robotics.

Content

1.) Wave propagation in continuous systems
2.) Wave properties
3.) Discrete systems
4.) Local resonances
5.) Topology by example
6.) Topological classification
7.) Static systems
8.) Non-linear waves

Lecture notes

Hand-outs will be available in class.
Abstract
The goal of the course is to help the audience to keep abreast of the strong advances there have been in the study of the high energy limit of scattering amplitudes in the last decade.

Objective
The goal of the course is to help the audience to keep abreast of the strong advances there have been in the study of the high energy limit of scattering amplitudes in the last decade.

Content
- the BFKL Hamiltonian as an integrable model
- the analytic structure of the Mueller-Navelet jet cross sections in QCD
- the analytic properties of N=4 SYM amplitudes in multi-Regge kinematics

Prerequisites / notice
follow-up of the block course "An Introduction to the Perturbative Pomeron and to the BFKL Equation in QCD and in N=4 SYM"

Selection: Astronomy

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<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0353-63L</td>
<td>Observational Techniques in Astrophysics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>K. Schawinski</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course introduces analysis techniques, the basics of astronomical instruments, real-world observational tools, data reduction strategy and software packages used in astrophysics research. The course will also include discussions of current topics in astrophysics with a focus on active galaxies. The course will include the reduction and analysis of real data from a variety of observatories.</td>
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<tr>
<td>Objective</td>
<td>The goal is to acquaint students with the basics of a range of astrophysical observation techniques including the modern software tools needed to analyze data.</td>
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<tr>
<td>Content</td>
<td>Major topics include: -Scientific programming and analysis tools -How to set up your computing environment, data management, catalog generation and the Virtual Observatory, collaborative tools -Optical imaging and spectroscopy: Basics of observatories (ground vs space), multi-wavelength data, detector types, reduction and analysis strategies for imaging and spectroscopic data, types of spectrographs, interpreting spectra including stellar and galaxy evolution models -X-ray, IR and radio astronomy Basics of X-ray and high energy detectors and telescopes, spectral fitting, basics of radio astronomy, interferometric observations, aperture synthesis, source confusion and decomposition -Planning of observations and proposal writing. -Analysis of real-world data Various examples from across the spectrum (ground and space-based)</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Astrophysics I is required and Astrophysics II is recommended. Some programming skills in Python or similar languages are necessary.</td>
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<tr>
<td>402-0375-63L</td>
<td>Statistical Methods in Cosmology and Astrophysics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>A. Amara</td>
</tr>
<tr>
<td>Abstract</td>
<td>Statistical methods play a vital role in modern cosmology and astrophysics studies. This course will give an overview of the statistical principles and tools that are used in these fields. Topics covered will include basic probability theory, Bayesian inference, hypothesis testing, sampling and estimators.</td>
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<tr>
<td>Objective</td>
<td>Develop an understanding of basic probability and statistical theory. Gain practical knowledge of statistical methods commonly used in cosmology and astrophysics.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Credit or current enrollment in Astrophysics I is recommended but not required</td>
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<tr>
<td>402-0381-64L</td>
<td>Hot Topics in Astrophysics</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>M. Carollo</td>
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<tr>
<td>Abstract</td>
<td>The themes we will discuss this year are: (1) How do baryons and dark matter interact? (2) Where, and in what state, do baryons reside within dark matter halos?</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to understand some of the phenomena that stand in the forefront of current research in astrophysics, the physical processes behind them, and how these phenomena are observed by state-of-the-art astronomical facilities. These goals will be achieved by communal discussions, led by the students and chaired by the teachers.</td>
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Selection: Neuroinformatics

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<tr>
<td>227-1033-00L</td>
<td>Neuromorphic Engineering I</td>
<td>W</td>
<td>6</td>
<td>2V+3U</td>
<td>T. Delbrück, G. Indiveri, S.C. Liu</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.</td>
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<td>Objective</td>
<td>Understanding of the characteristics of neuromorphic circuit elements.</td>
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<td>Content</td>
<td>Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.</td>
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<tr>
<td>Literature</td>
<td>S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Particular: The course is highly recommended for those who intend to take the spring semester course ‘Neuromorphic Engineering II’, that teaches the conception, simulation, and physical layout of such circuits with chip design tools.</td>
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<tbody>
<tr>
<td>227-1037-00L</td>
<td>Introduction to Neuroinformatics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>K. A. Martin, M. Cook, V. Mante, M. Pfeiffer</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.</td>
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</table>
**Objective**
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

**Content**
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

### Selection: Biophysics, Physical Chemistry

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td>551-1601-00L</td>
<td>Biophysics of Biological Macromolecules</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>G. Wider, F. Allain</td>
</tr>
</tbody>
</table>

**Abstract**
This lecture course targets physics students and students of interdisciplinary sciences (major physics) for their education in biophysics. In this course the basics of molecular biology are presented bearing in mind the special interests of the physics students.

**Objective**
Basics of molecular biology and biophysics in in view of the special interest of students in physics.

**Content**
This lecture course targets physics students and students of interdisciplinary sciences (major physics) for their education in biophysics. In this course the basics of molecular biology are presented bearing in mind the special interests of the physics students. The topics include: properties of biological macromolecules, introduction to the genetic system of E.coli bacteria, transcription, translation, discussion of structure and function of proteins, quantitative description of enzyme function and allosteric interactions, biotechnology, introduction to optical spectroscopy, X-ray crystallography and nuclear magnetic resonance (NMR) spectroscopy of biopolymers in solution.

**Lecture notes**
- additional documentation in support of text book

**Prerequisites / notice**
small classes with active participation of students

### Selection: Medical Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0341-00L</td>
<td>Medical Physics I</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>P. Manser</td>
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</table>

**Abstract**
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

**Objective**
Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.

**Content**
The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the excercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerators, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications. A script will be provided.

**Lecture notes**
- additional documentation in support of text book

| 402-0674-00L | Physics in Medical Research: From Atoms to Cells | W    | 6 credits | 2V+1U | B. K. R. Müller |

**Abstract**
Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

### Selection: Environmental Physics

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0572-00L</td>
<td>Aerosols I: Physical and Chemical Principles</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>M. Gysel, U. Baltensperger, H. Bürtscher</td>
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<tr>
<td>Abstract</td>
<td>Aerosols I deals with basic physical and chemical properties of aerosol particles. The importance of aerosols in the atmosphere and in other fields is discussed.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of basic physical and chemical properties of aerosol particles and their importance in the atmosphere and in other fields</td>
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<tr>
<td>Content</td>
<td>Physical and chemical properties of aerosols, aerosol dynamics (diffusion, coagulation...), optical properties (light scattering, absorption, extinction), aerosol production, physical and chemical characterization.</td>
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<tr>
<td>Lecture notes</td>
<td>Material is distributed during the lecture</td>
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### Selection: Mathematics

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<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-3531-00L</td>
<td>Differential Geometry I</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>U. Lang</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from neither 401-3531-00L Differential Geometry I nor 401-3532-00L Differential Geometry II for their Bachelor's degree still can have recognised this course for the Master's degree. Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.</td>
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<tr>
<td>Objective</td>
<td>Introduction to elementary differential geometry and differential topology.</td>
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</table>
| Content         | - Differential geometry in \( \mathbb{R}^n \): theory of curves, submanifolds and immersions, inner geometry of hypersurfaces, Gauss map and curvature, Theorema Egregium, special classes of surfaces, Theorem of Gauss-Bonnet, Hyperbolic space. Differentiable manifolds, tangent bundle, immersions and embeddings, Sard's Theorem, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.  
- The hyperbolic space.  
- Differential topology: differentiable manifolds, tangent bundle, immersions and embeddings in \( \mathbb{R}^n \), Sard's Theorem, transversality, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem. |
| Literature      | Differential Geometry in \( \mathbb{R}^n \):  
- Manfredo P. do Carmo: Differential geometry of curves and surfaces  
- Wolfgang Kühnel: Differentialgeometrie. Curves-surfaces-manifolds  
- Christian Bär: Elementary differential geometry  
- Differential Topology:  
- Dennis Barden & Charles Thomas: An Introduction to Differential Manifolds  
- Victor Guillemin & Alan Pollack: Differential Topology  
- Morris W. Hirsch: Differential Topology |
The course begins with characteristics, the definition of hyperbolicity,
W. R. Teyssier
4V+1U
Basics of probability theory and the theory of stochastic processes in discrete time
Partial Differential Equations (Hyperbolic PDEs)
The course covers the basics of inferential statistics.
Lecturers
Fundamentals of Mathematical Statistics
This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are
The course shall begin with the basic structure associated to hyperbolic
A. S. Sznitman
Theoretical Astrophysics (University of Zurich)
available, will be sold in the course
4V+2U
M. Struwe
Functional Analysis I
This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from neither 401-3461-00L Functional Analysis I nor 401-3462-00L Functional Analysis II for their Bachelor's degree still can have recognised this course for the Master's degree.
Furthermore, at most one of the three course units
401-3461-00L Functional Analysis I
401-3531-00L Differential Geometry I
401-3581-00L Probability Theory
can be recognised for the Master's degree in Mathematics or Applied Mathematics.
Abstract
Baer category; Banach and Hilbert spaces, bounded linear operators; three fundamental principles: Uniform boundedness, open mapping/closed graph theorem, Hahn-Banach; convexity; dual spaces; weak and weak* topologies; Banach-Alaoglu; reflexive spaces; compact operators and Fredholm theory; closed range theorem; spectral theory of self-adjoint operators in Hilbert spaces.
Lecture notes
Lecture Notes on "Funktionalanalysis I" by Michael Struwe
401-3601-00L Probability Theory
This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from none of the three course units 401-3601-00L Probability Theory, 401-3642-00L Brownian Motion and Stochastic Calculus resp. 401-3602-00L Applied Stochastic Processes for their Bachelor's degree still can have recognised this course for the Master's degree.
Furthermore, at most one of the three course units
401-3461-00L Functional Analysis I
401-3531-00L Differential Geometry I
401-3801-00L Probability Theory
can be recognised for the Master's degree in Mathematics or Applied Mathematics.
Abstract
Basics of probability theory and the theory of stochastic processes in discrete time
Objective
This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:
Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.
Content
This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:
Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.
Lecture notes
available, will be sold in the course
Literature
H. Bauer, Probability Theory, de Gruyter 1996
J. Jacod and P. Protter, Probability essentials, Springer 2004
A. Klenke, Wahrscheinlichkeitstheorie, Springer 2006
D. Williams, Probability with martingales, Cambridge University Press 1991
401-3621-00L Fundamentals of Mathematical Statistics
This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from none of the three course units 401-3601-00L Probability Theory, 401-3642-00L Brownian Motion and Stochastic Calculus resp. 401-3602-00L Applied Stochastic Processes for their Bachelor's degree still can have recognised this course for the Master's degree.
Furthermore, at most one of the three course units
401-3461-00L Functional Analysis I
401-3531-00L Differential Geometry I
401-3801-00L Probability Theory
can be recognised for the Master's degree in Mathematics or Applied Mathematics.
Abstract
The course covers the basics of inferential statistics.
Objective
This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:
Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.
Content
This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:
Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.
Lecture notes
available, will be sold in the course
Literature
H. Bauer, Probability Theory, de Gruyter 1996
J. Jacod and P. Protter, Probability essentials, Springer 2004
A. Klenke, Wahrscheinlichkeitstheorie, Springer 2006
D. Williams, Probability with martingales, Cambridge University Press 1991
401-3842-00L Partial Differential Equations (Hyperbolic PDEs)
The course begins with characteristics, the definition of hyperbolicity, causal structure and the domain of dependence theorem. The course then focuses on nonlinear systems of equations in two independent variables, in particular the Euler equations of compressible fluids with plane symmetry and the Einstein equations of general relativity with spherical symmetry.
Abstract
The course begins with characteristics, the definition of hyperbolicity, causal structure and the domain of dependence theorem. The course then focuses on nonlinear systems of equations in two independent variables, in particular the Euler equations of compressible fluids with plane symmetry and the Einstein equations of general relativity with spherical symmetry.
Objective
The objective is to introduce students in mathematics and physics to an area of mathematical analysis involving differential geometry which is of fundamental importance for the development of classical macroscopic continuum physics.
Content
The course shall begin with the basic structure associated to hyperbolic partial differential equations, characteristic hypersurfaces and bicharacteristics, causal structure, and the domain of dependence theorem. The course shall then focus on nonlinear systems of equations in two independent variables. The first topic shall be the Euler equations of compressible fluids under plane symmetry where we shall study the formation of shocks, and second topic shall be the Einstein equations of general relativity under spherical symmetry where we shall study the formation of black holes and spacetime singularities.
Prerequisites / notice
Basic real analysis and differential geometry.

爔Selection: Electives at the University of Zurich

University of Zurich lecturers explicitly recommended the following courses also to physics students at ETH Zurich. Recognition of the corresponding external ECTS credits has to be granted by the Director of Studies. Submit your request to the Study Administration (www.phys.ethz.ch/studies/study-administration.html).

Number	Title	Type	ECTS	Hours	Lecturers
401-7851-00L	Theoretical Astrophysics (University of Zurich) No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: AST512
	W	10 credits	4V+2U
	R. Teyssier
The exploration of topological phases of matter is to a large extent introduced to students through the study of statistical mechanics and thermodynamics. Prediction of thermodynamic and kinetic properties from molecular data.

H.M. Prasser


Additionaly PowerPoint slides will be prepared by the lecturer on these and extra topics (e.g. planet formation).

Prerequisites / notice
Prerequisites: Elementary atomic physics, thermodynamics, mechanics, fluid dynamics. Introduction to astrophysics (preferred but not obligatory).

401-7855-00L Computational Astrophysics (University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: AST245

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programs.

Objective
Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programs.

Content
1. Integration of ODE, Hamiltonians and Symplectic integration techniques, time adaptivity, time reversibility
2. Large-N gravity calculation, collisionless N-body systems and their simulation
3. Fast Fourier Transform and spectral methods in general
4. Eulerian Hydrodynamics: Upwinding, Riemann solvers, Limiters
5. Lagrangian Hydrodynamics: The SPH method
6. Resolution and instabilities in Hydrodynamics
7. Initial Conditions: Cosmological Simulations and Astrophysical Disks
8. Physical Approximations and Methods for Radiative Transfer in Astrophysics

Literature
Galactic Dynamics (Binney & Tremaine, Princeton University Press), No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

Computer Simulation using Particles (Hockney & Eastwood CRC press), Targeted journal reviews on computational methods for astrophysical fluids (SPH, AMR, moving mesh)

Prerequisites / notice
Some knowledge of UNIX, scripting languages (see www.physik.uzh.ch/lectures/informatik/python/ as an example), some prior experience programming, knowledge of C, C++ beneficial.

402-6821-66L Understanding Topological Phases of Matter from Toy Models (University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: PHY576

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
In this course, we will study classic models such as the Su-Schrieffer-Heeger model, Kitaev’s Majorana chain, and the toric code. We will use them to understand topological band insulators and the basic concepts of topological order in systems with anyon excitations.

Content
The exploration of topological phases of matter is to a large extend guided by a range of exactly soluble toy models that illustrate the physics at play. In this course, we will study classic models such as the Su-Schrieffer-Heeger model, Kitaev’s Majorana chain, and the toric code. We will use them to understand topological band insulators and the basic concepts of topological order in systems with anyon excitations.

Prerequisites / notice
None.

General Electives

Students may choose General Electives from the entire course programme of ETH Zurich - with the following restrictions: courses that belong to the first or second year of a Bachelor curriculum at ETH Zurich as well as courses from GESS "Science in Perspective" are not eligible here.

The following courses are explicitly recommended to physics students by their lecturers. (Courses in this list may be assigned to the category "General Electives" directly in myStudies. For the category assignment of other eligible courses keep the choice "no category" and take contact with the Study Administration (www.phys.ethz.ch/studies/study-administration.html) after having received the credits.)

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0433-00L</td>
<td>Advanced Physical Chemistry: Statistical</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>G. Jeschke</td>
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<td></td>
<td>Thermodynamics</td>
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<tr>
<td>Abstract</td>
<td>Introduction to statistical mechanics and</td>
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<td>thermodynamics. Prediction of thermodynamic</td>
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<td>and kinetic properties from molecular data.</td>
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<td>Content</td>
<td>Basics of statistical mechanics and</td>
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<td>thermodynamics of classical and quantum</td>
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<td>systems. Concept of ensembles, microcanonical</td>
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<td>and canonical ensembles, ergodic theorem.</td>
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<td>Molecular and canonical partition functions</td>
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<td>and their connection with classical</td>
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<td>thermodynamics. Translational, rotational,</td>
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<td>vibrational, electronic and nuclear spin</td>
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<td>partition functions of gases. Determination</td>
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<td>of the equilibrium constants of gas</td>
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<td>phase reactions. Transition state theory</td>
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<td>and its connection with collision theory.</td>
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<td>Description of ideal gases and ideal</td>
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<tr>
<td>Lecture notes</td>
<td>See homepage of the lecture.</td>
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<tr>
<td>Literature</td>
<td>See homepage of the lecture.</td>
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<tr>
<td>Prerequisites</td>
<td>Chemical Thermodynamics, Reaction Kinetics,</td>
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<td>Molecular Quantum Mechanics and Spectroscopy;</td>
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<td>Mathematical Foundations (Analysis,</td>
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<td>Combinatorial Relations, Integral and</td>
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<td>Differential Calculus)</td>
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<tr>
<td>151-0163-00L</td>
<td>Nuclear Energy Conversion</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>H.M. Prasser</td>
</tr>
<tr>
<td>Abstract</td>
<td>Physical fundamentals of the fission reaction and the sustainable chain reaction, thermal design, construction, function and operation of nuclear reactors and power plants, light water reactors and other reactor types, conversion and breeding</td>
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</table>
Objective
Students get an overview on energy conversion in nuclear power plants, on construction and function of the most important types of nuclear reactors with special emphasis to light water reactors. They obtain the mathematical/physical basis for quantitative assessments concerning most relevant aspects of design, dynamic behaviour as well as material and energy flows.

Content
Nuclear physics of fission and chain reaction. Thermodynamics of nuclear reactors. Design of the rector core. Introduction into the dynamic behaviour of nuclear reactors. Overview on types of nuclear reactors, difference between thermal reactors and fast reactors. Construction and operation of nuclear power plants with pressurized and boiling water reactors, role and function of the most important safety systems, special features of the energy conversion. Development tendencies of rector technology.

Lecture notes
Hand-outs will be distributed. Additional literature and information on the website of the lab: https://www.ethz.ch/content/specialinterest/mav/energy-technology/lab-of-nuclear-energy-systems/en/studium/teaching-materials/151-0163-00-nuclear-energy-conversion.html

Literature

R. L. Murray: Nuclear Energy (Sixth Edition), An Introduction to the Concepts, Systems, and Applications of Nuclear Processes, Elsevier

151-0103-00L Fluid Dynamics II W 3 credits 2V+1U F. Jenny

Abstract

Objective
Expand basic knowledge of fluid dynamics. Concepts, phenomena and quantitative description of irrotational (potential), rotational, and one-dimensional compressible flows.

Content

Lecture notes
Lecture notes are available (in German). (See also info on lecture notes below.)

Literature


Prerequisites / notice
Analysis I/II, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

151-0532-00L Nonlinear Dynamics and Chaos I W 4 credits 2V+2U G. Haller, F. Kogelbauer

Abstract
Basic facts about nonlinear systems; stability and near-equilibrium dynamics; bifurcations; dynamical systems on the plane; non-autonomous dynamical systems; chaotic dynamics.

Objective
This course is intended for Masters and Ph.D. students in engineering sciences, physics and applied mathematics who are interested in the behavior of nonlinear dynamical systems. It offers an introduction to the qualitative study of nonlinear physical phenomena modeled by differential equations or discrete maps. We discuss applications in classical mechanics, electrical engineering, fluid mechanics, and biology. A more advanced Part II of this class is offered every other year.

Content
(1) Basic facts about nonlinear systems: Existence, uniqueness, and dependence on initial data.

(2) Near equilibrium dynamics: Linear and Lyapunov stability

(3) Bifurcations of equilibria: Center manifolds, normal forms, and elementary bifurcations

(4) Nonlinear dynamical systems on the plane: Phase plane techniques, limit sets, and limit cycles.

(5) Time-dependent dynamical systems: Floquet theory, Poincare maps, averaging methods, resonance

Lecture notes
The class lecture notes will be posted electronically after each lecture. Students should not rely on these but prepare their own notes during the lecture.

- Prerequisites: Analysis, linear algebra and a basic course in differential equations.

- Exam: two-hour written exam in English.

- Homework: A homework assignment will be due roughly every other week. Hints to solutions will be posted after the homework due dates.

151-0213-00L Fluid Dynamics with the Lattice Boltzmann Method W 4 credits 3G I. Karlin

Abstract
The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations.

Objective
Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.

During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on.

Central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course).

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microlows among others.

Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.
The course builds upon three parts:
I Elementary kinetic theory and lattice Boltzmann simulations introduced on simple examples.
II Theoretical basis of statistical mechanics and kinetic equations.
III Lattice Boltzmann method for real-world applications.

The content of the course includes:

1. Background: Elements of statistical mechanics and kinetic theory:
   - Particle's distribution function, Liouville equation, entropy, ensembles
   - Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vaslov equation
   - Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

2. Basics of the Lattice Boltzmann Method and Simulations:
   - Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

3. Hands on:
   - Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).

4. Practical issues of LBM for fluid dynamics simulations:
   - Lattice Boltzmann simulations of turbulent flows; numerical stability and accuracy.

5. Microflow:
   - Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.

6. Advanced lattice Boltzmann methods:
   - Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.

7. Introduction to LBM models beyond hydrodynamics:
   - Relativistic fluid dynamics; flows with phase transitions.

Lecture notes
- Lecture notes on the theoretical parts of the course will be made available.
- Selected original and review papers are provided for some of the lectures on advanced topics.
- Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.

Prerequisites / notice
- The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.

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### 151-0105-00L Quantitative Flow Visualization

**Abstract**
The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.

**Objective**
Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization.

**Content**
- Fundamentals of optics, flow visualization and electronic image acquisition.
- Frequently used mage processing techniques (filtering, correlation processing, FFTs, color space transforms).
- Image Velocimetry (tracking, pattern matching, Doppler imaging).
- Surface pressure and temperature measurements (fluorescent paints, liquid crystal imaging, infrared thermography).
- Laser induced fluorescence.
- (Digital) Schlieren techniques, phase contrast imaging, interferometry, phase unwrapping.
- Wall shear and heat transfer measurements.
- Pattern recognition and feature extraction, proper orthogonal decomposition.

**Lecture notes**
- Lecture notes on quantitative flow visualization are available.

**Prerequisites / notice**
- Prerequisites: Fluiddynamics I, Numerical Mathematics, programming skills.
- Language: German on request.

---

### 151-0911-00L Introduction to Plasmonics

**Abstract**
This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.

**Objective**
Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

**Content**
- Fundamentals of Plasmonics
  - Basic electromagnetic theory
  - Optical properties of metals
  - Surface plasmon polaritons on surfaces
  - Surface plasmon polariton propagation
  - Localized surface plasmons
- Applications of Plasmonics
  - Waveguides
  - Extraordinary optical transmission
  - Enhanced spectroscopy
  - Sensing
  - Metamaterials

**Lecture notes**
- Class notes and handouts

**Literature**
- Physics I, Physics II

**Prerequisites / notice**

---

### 151-0107-20L High Performance Computing for Science and Engineering (HPCSE) I

**Abstract**

**Objective**

**Content**

**Lecture notes**

**Literature**

**Prerequisites / notice**

---
**Abstract**

This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

**Objective**

Introduction to HPC for scientists and engineers

Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

**Content**

Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

---

**227-1047-00L**

**Consciousness: From Philosophy to Neuroscience**

(University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: INI410

**Abstract**

This seminar reviews the philosophical and phenomenological as well as the neurobiological aspects of consciousness. The subjective features of consciousness are explored, and modern research into its neural substrate, particularly in the visual domain, is explained. Emphasis is placed on students developing their own thinking through a discussion-centered course structure.

**Objective**

The course's goal is to give an overview of the contemporary state of consciousness research, with emphasis on the contributions brought by modern cognitive neuroscience. We aim to clarify concepts, explain their philosophical and scientific backgrounds, and to present experimental protocols that shed light on a variety of consciousness related issues.

**Content**

The course includes discussions of scientific as well as philosophical articles. We review current schools of thought, models of consciousness, and proposals for the neural correlate of consciousness (NCC).

Lecture notes
None

**Literature**

We display articles pertaining to the issues we cover in the class on the course's webpage.

**Prerequisites / notice**

Since we are all experts on consciousness, we expect active participation and discussions!

---

**227-0385-10L**

**Biomedical Imaging**

W 6 credits 5G S. Kozerke, K. P. Prüssmann, M. Rudin

**Abstract**

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

**Objective**

To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

**Content**

- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes
Lecture notes and handouts

**Literature**

Weeb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

**Prerequisites / notice**

Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming
Objective

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Content


Lecture notes

Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

AND

https://www1.ethz.ch/lbb/Education/BME

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Prerequisites / Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0157-00L</td>
<td>Semiconductor Devices: Physical Bases and Simulation</td>
<td>4</td>
<td>W</td>
<td>Further reading will be recommended in the lecture.</td>
</tr>
<tr>
<td>227-0147-00L</td>
<td>VLSI II: Design of Very Large Scale Integration Circuits</td>
<td>7</td>
<td>W</td>
<td>This second course in our VLSI series is concerned with how to turn digital circuit netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects. Low-power circuit design is another important topic. Economic aspects and management issues of VLSI projects round off the course.</td>
</tr>
</tbody>
</table>

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1266 of 1571
The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI. Topics include:

- The difficulties of finding fabrication defects in large VLSI chips.
- How to make integrated circuit testable (design for test).
- Synchronous clocking disciplines compared, clock skew, clock distribution, input/output timing.
- Synchronization and metastability.
- CMOS transistor-level circuits of gates, flip-flops and random access memories.
- Sinks of energy in CMOS circuits.
- Power estimation and low-power design.
- Current research in low-energy computing.
- Layout parasitics, interconnect delay, static timing analysis.
- Switching currents, ground bounce, IR-drop, power distribution.
- Floorplanning, chip assembly, packaging.
- Layout design at the mask level, physical design verification.
- Electromigration, electrostatic discharge, and latch-up.
- Models of industrial cooperation in microelectronics.
- The caveats of virtual components.
- The cost structures of ASIC development and manufacturing.
- Market requirements, decision criteria, and case studies.
- Yield models.
- Avenues to low-volume fabrication.
- Marketing considerations and case studies.
- Management of VLSI projects.

Exercises are concerned with back-end design (floorplanning, placement, routing, clock and power distribution, layout verification). Industrial CAD tools are being used.

Lecture notes

All written documents in English.

Literature

Highlight:
Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.

Prerequisites:
"VLSI I: from Architectures to Very Large Scale Integration Circuits and FPGAs" or equivalent knowledge.

Further details:
http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html

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<tr>
<td>227-0301-00L</td>
<td>Optical Communication Fundamentals</td>
<td>6 credits</td>
<td>- Physics I+II</td>
<td>J. Leuthold</td>
</tr>
<tr>
<td>151-0620-00L</td>
<td>Embedded MEMS Lab</td>
<td>5 credits</td>
<td>- Physics I+II</td>
<td>Govind P. Agrawal: &quot;Fiber-Optic Communication Systems&quot;; Wiley, 2010</td>
</tr>
</tbody>
</table>
Students learn the individual process steps that are required to make a MEMS (Micro Electro Mechanical System). Students carry out the process steps themselves in laboratories and clean rooms. Furthermore, participants become familiar with the special requirements (cleanliness, safety, operation of equipment and handling hazardous chemicals) of working in the clean rooms and laboratories. The entire production, processing, and characterization of the MEMS is documented and evaluated in a final report.

With guidance from a tutor, the individual silicon microsystem process steps that are required for the fabrication of an accelerometer are carried out:
- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Packaging and electrical connection of a MEMS device
- Testing and characterization of the MEMS device
- Written documentation and evaluation of the entire production, processing and characterization

A document containing theory, background and practical course content is distributed at the first meeting of the course. The document provides sufficient information for the participants to successfully participate in the course.

Participating students are required to attend all scheduled lectures and meetings of the course.

Participating students are required to provide proof that they have personal accident insurance prior to the start of the laboratory portion of the course.

This master's level course is limited to 15 students per semester for safety and efficiency reasons.

If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

Priority 1: master students of the master's program in "Micro and Nanosystems”

Priority 2: master students of the master's program in “Mechanical Engineering” with a specialization in Microsystems and Nanoscale Engineering (MAVT-tutors Profs Daraio, Dual, Hierold, Kourmoutsakos, Nelson, Norris, Park, Poulikakos, Pratsinis, Stemmer), who attended the bachelor course "151-0621-00L Microsystems Technology” successfully.

Priority 3: master students, who attended the bachelor course "151-0621-00L Microsystems Technology” successfully.

Priority 4: all other students (PhD, bachelor, master) with a background in silicon or microsystems process technology.

If there are more students in one of these priority groups than places available, we will decide by drawing lots.

Students will be notified at the first lecture of the course (introductory lecture) as to whether they are able to participate.

The course is offered in autumn and spring semester.
- Set-up, align and operate a SEM successfully and safely.
- Accomplish imaging tasks successfully and optimize microscope performances.
- Master the operation of a low-vacuum and field-emission SEM and EDX instrument.
- Perform sample preparation with corresponding techniques and equipment for imaging and analysis
- Acquire techniques in obtaining secondary electron and backscatter electron micrographs
- Perform EDX qualitative and semi-quantitative analysis

Content

During the course, students learn through lectures, demonstrations, and hands-on sessions how to setup and operate SEM instruments, including low-vacuum and low-voltage applications.

This course gives basic skills for students new to SEM. At the end of the course, students with no prior experience are able to align a SEM, to obtain secondary electron (SE) and backscatter electron (BSE) micrographs and to perform energy dispersive X-ray spectroscopy (EDX) qualitative and semi-quantitative analysis. The procedures to better utilize SEM to solve practical problems and to optimize SEM analysis for a wide range of materials will be emphasized.

- Discussion of students' sample/interest
- Introduction and discussion on Electron Microscopy and instrumentation
- Lectures on electron sources, electron lenses and probe formation
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM
- Brief description and demonstration of the SEM microscope
- Practice on beam/specimen interaction, image formation, image contrast and imaging modes.
- Student participation on sample preparation techniques
- Scanning Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities
- Lecture and demonstrations on X-ray micro-analysis (theory and detection), qualitative and semi-quantitative EDX and point analysis, linescans and spectral mapping
- Practice on real-world samples and report results

Literature

- Detailed course manual

Prerequisites / notice

No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

327-2126-00L Microscopy Training TEM I - Introduction to TEM W 1 credit 3P

The participants will be chosen based on a short motivation letter. Please send this letter to S. Rodighiero (main lecturer).

Abstract

The introductory course on Transmission Electron Microscopy (TEM) provides theoretical and hands-on learning for new operators, utilizing lectures, demonstrations, and hands-on sessions.

Objective

- Overview of TEM theory, instrumentation, operation and applications.
- Alignment and operation of a TEM, as well as acquisition and interpretation of images, diffraction patterns, accomplishing basic tasks successfully.
- Knowledge of electron imaging modes (including Scanning Transmission Electron Microscopy), magnification calibration, and image acquisition using CCD cameras.
- To set up the TEM to acquire diffraction patterns, perform camera length calibration, as well as measure and interpret diffraction patterns.
- Overview of techniques for specimen preparation.

Content

Using two Transmission Electron Microscopes the students learn how to align a TEM, select parameters for acquisition of images in bright field (BF) and dark field (DF), perform scanning transmission electron microscopy (STEM) imaging, phase contrast imaging, and acquire electron diffraction patterns. The participants will also learn basic and advanced use of digital cameras and digital imaging methods.

- Introduction and discussion on Electron Microscopy and instrumentation.
- Lectures on electron sources, electron lenses and probe formation.
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM.
- Brief description and demonstration of the TEM microscope.
- Practice on beam/specimen interaction, image formation, Image contrast and (image processing).
- Demonstration of Transmission Electron Microscopes and imaging modes (Phase contrast, BF, DF, STEM).
- Student participation on sample preparation techniques.
- Transmission Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.
- TEM alignment, calibration, correction to improve image contrast and quality.
- Electron diffraction.
- Practice on real-world samples and report results.

Literature

- Detailed course manual

Prerequisites / notice

No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

363-0541-00L Systems Dynamics and Complexity W 3 credits 3G

Abstract

Finding solutions: what is complexity, problem solving cycle.

Implementing solutions: project management, critical path method, quality control feedback loop.

Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption

Objective

A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics
Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

### Prerequisites / notice

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.

The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

Self-study tasks (discussion exercises, VENSIM exercises), are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

### Proseminars and Semester Papers

To organise a semester project take contact with one of the instructors.

Not all lecturers are directly eligible in myStudies if "Professors" is the required type of lecturers. In such cases please take contact with the Study Administration (www.phys.ethz.ch/studies/study-administration.html).

#### Number Title Type ECTS Hours Lecturers

| 402-0210-96L | Proseminar Theoretical Physics: Solitons and Instantons in Condensed Matter | W | 9 credits | 4S | V. Geshkenbein |
| 402-0217-MSL | Theoretical Semester Project in a Group of the Physics Department | W | 9 credits | 18A | Supervisors |

**Abstract**

A guided self-study of original papers and of advanced textbooks in theoretical physics. Within the general topic, determined each semester, participants give a presentation on a particular subject and deliver a written report.

---

**Content**

Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

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#### Number Title Type ECTS Hours Lecturers

| 402-0210-96L | Proseminar Theoretical Physics: Solitons and Instantons in Condensed Matter | W | 9 credits | 4S | V. Geshkenbein |
| 402-0217-MSL | Theoretical Semester Project in a Group of the Physics Department | W | 9 credits | 18A | Supervisors |

**Abstract**

A guided self-study of original papers and of advanced textbooks in theoretical physics. Within the general topic, determined each semester, participants give a presentation on a particular subject and deliver a written report.
This course unit is an alternative if no suitable "Proseminar Theoretical Physics" is available or if the proseminar is already overbooked.

Prerequisites / notice
Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit. Vorträge können ein zusätzlicher Bestandteil der Leistungskontrolle sein.

402-0215-MSL
Experimental Semester Project in a Group of the Physics Department

Abstract
The aim of the project is to give the student experience in working in a research environment, carrying out physics experiments, analysing and interpreting the resulting data.

Prerequisites / notice

402-0510-MSL
Advanced Solid State Physics Experiments

Abstract
Experiments in condensed matter physics. The work includes the planning, build-up, data taking and analysis, and interpretation of the experimental results.

Objective

Content

Lecture notes
n/a

Prerequisites / notice
Arbeiten in einer Forschungsgruppe sind besonders gut geeignet, die Studierenden mit aktuellen Forschungsthemen und mit moderner Instrumentierung bekannt zu machen.

402-0400-MSL
Advanced Quantum Electronics Experiments

Abstract
Implementation of experiments in quantum electronics. Planning, design, realisation, evaluation, and interpretation of the experiments.

Objective

Content

Prerequisites / notice
Language of instruction: English or German

402-0717-MSL
Particle Physics at CERN

Abstract
During the semester break participating students stay for 4 weeks at CERN and perform experimental work relevant to our particle physics projects. Dates to be agreed upon.

Objective
Students learn, by doing, the needed skills to perform a small particle physics experiment: setup, problem solving, data taking, analysis, interpretation and presentation in a written report of publication quality.

Content
Detailed information in: http://www/cmsdoc.cern.ch/~nessif/ETHTeilchenpraktikumCERN.html

402-0719-MSL
Particle Physics at PSI (Paul Scherrer Institute)

Abstract
During semester breaks 6-12 students stay for 3 weeks at PSI and participate in a hands-on course on experimental particle physics. A small real experiment is performed in common, including apparatus design, construction, running and data analysis. The course includes some lectures, but the focus lies on the practical aspects of experimenting.

Objective
Students learn all the different steps it takes to perform a complete particle physics experiment in a small team. They acquire skills to do this themselves in the team, including design, construction, data taking and data analysis.

402-0340-MSL
Medical Physics

Abstract
In agreement with the lecturers a semester paper in the context of the topics discussed in the lectures can be written.

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-PHYS.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Master's Thesis (Programme Regulations 2007)

<table>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>402-2000-00L</td>
<td>Scientific Works in Physics</td>
<td>O</td>
<td>0</td>
<td></td>
<td>C. Grab</td>
</tr>
</tbody>
</table>
Abstract

Literature Review: ETH-Library, Journals in Physics, Google Scholar; Thesis Structure: The IMRAD Model; Document Processing: LaTeX and BibTeX, Mathematical Writing, AVETH Survival Guide; ETH Guidelines for Integrity; Authorship Guidelines; ETH Citation Etiquettes; Declaration of Originality.

Objective

Basic standards for scientific works in physics: How to write a Master Thesis. What to know about research integrity.

402-0900-00L Master's Thesis

Only students who fulfill the following criteria are allowed to begin with their master's thesis:

a. successful completion of the bachelor programme;

b. fulfilling of any additional requirements necessary to gain admission to the master programme.

c. have acquired at least 9 credits in the category Proseminars and Semester Papers.

Please send the completed form
to the Study Administration

Further information:
www.phys.ethz.ch/phys/education/master/msc-theses

Abstract

The master's thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

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<tbody>
<tr>
<td>402-0900-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>57D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

Abstract

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</thead>
<tbody>
<tr>
<td>402-0247-00L</td>
<td>Electronics for Physicists I (Analogue)</td>
<td>Z</td>
<td>4 credits</td>
<td>2V+2P</td>
<td>R. Horisberger</td>
</tr>
</tbody>
</table>

Abstract

Passive elements, linear complex networks, transmission lines, simulation of analog circuits, semiconductor elements: diodes, bipolar and field-effect transistors, basic amplifier circuits, small signal analysis, differential amplifiers, noise in analog circuits, operational amplifiers, OTA's, gyrrator circuits, feedback and stability in amplifiers, oscillators, ADCs and DACs, introduction in CMOS technology

Content

Passive elements, linear complex networks, transmission lines, simulation of analog circuits (SPICE), semiconductor elements: diodes, bipolar and field-effect transistors, basic amplifier circuits, small signal analysis, differential amplifiers, noise in analog circuits, operational amplifiers, OTA's, gyrrator circuits, feedback and stability in amplifiers, oscillators, ADC's and DAC's, introduction in CMOS technology.

Prerequisites / notice


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</table>
402-0800-00L  The Zurich Theoretical Physics Colloquium  E-  0 credits  1K

Objective
The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.

401-5330-00L  Talks in Mathematical Physics  E-  0 credits  1K
  A. Cattaneo, G. Felder, M. Gaberdiel, G. M. Graf, H. Knörrer, T. H. Willwacher, University lecturers

Abstract
Research colloquium

Objective
Stay informed about current research results in elementary particle physics.

402-0700-00L  Seminar in Elementary Particle Physics  E-  0 credits  1S
  M. Spira

Abstract
Research colloquium

Objective
Stay informed about current research results in elementary particle physics.

402-0369-00L  Research Colloquium in Astrophysics  E-  0 credits  1K
  S. Cantalupo, M. Carollo, S. Lilly, A. Refregier, K. Schawinski, H. M. Schmid

Abstract
During the semester there is a colloquium every week. In general, colloquia are 20 minutes plus discussion and are given by local researchers. They inform the other members of the Institute of Astronomy about their current work, results, problems and plans. Guests are always welcome.

Objective
Ph.D. students are expected to give a first research colloquium within their first years of their graduate time, another colloquium in their third year, and their doctoral exam talk before or after the exam. Other members of the institute are also invited to give talks. The goals are:
- keep other members of the institute oriented on current research
- test new ideas within the institute before going outside
- train students to give scientific talks

402-0476-00L  Seminar: Particle and Astrophysics  E-  0 credits  1S
  C. Grab, University lecturers

Abstract
Research colloquium

Content
In Seminarvorträgen werden aktuelle Fragestellungen aus der Teilchenphysik vom theoretischen und experimentellen Standpunkt aus diskutiert. Besonders wichtig erscheint uns der Bezug zu den eigenen Forschungsmöglichkeiten am PSI, CERN und DESY.

402-0396-00L  Mesoscopic Systems  E-  0 credits  1S
  T. M. Ihn

Abstract
Research colloquium

Content
In Seminarvorträgen werden aktuelle Fragestellungen aus der Teilchenphysik vom theoretischen und experimentellen Standpunkt aus diskutiert. Besonders wichtig erscheint uns der Bezug zu den eigenen Forschungsmöglichkeiten am PSI, CERN und DESY.
Invited talks on current research from the following areas: Auditory information processing, auditory sensors (biological and electrical), and Actuel developments and problems of magnetic resonance imaging (MRI). The goal of these talks is to provide insight into recent research results. The talks are not meant for the general public, but really aimed at specialists in the field.

The topics depend heavily on the invited speakers, and thus change from week to week. The topics concern neural computation and their implementation in biological or artificial systems.

### Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>406-0204-AAL</td>
<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
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<td>E-</td>
<td>7</td>
<td>15R</td>
<td>R. Hiptmair</td>
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**Abstract**

The seminar is aimed at all students who, during their studies, are confronted with age determination methods based on long-living radionuclides found in nature. Basic methodology, the latest developments, and special examples from a wide range of applications will be discussed.

**Objective**

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

- Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Abstract**


**Objective**

Develop a physical understanding for static and dynamic phenomena related to (moving) charged objects and understand the structure of the classical field theory of electrodynamics (transverse versus longitudinal physics, invariances (Lorentz-, gauge-)...). Appreciate the interrelation between electric, magnetic, and optical phenomena and the influence of media. Understand a set of classic electrodynamical phenomena and develop the ability to solve simple problems independently. Apply previously learned mathematical concepts (vector analysis, complete systems of functions, Green's functions, co- and contravariant coordinates, etc.). Prepare for quantum mechanics (eigenvalue problems, wave guides and cavities).

**Content**

Classical field theory of electrodynamics: Derivation and discussion of Maxwell equations, starting from the static limit (electrostatics, magnetostatics, boundary value problems) in the vacuum and in media and subsequent generalization to the full dynamical case (Faraday's law, Ampere/Maxwell law; potentials and gauge invariance), Wave equation and solutions in full space, half-space (Snell's law), waveguides, cavities, generation of electromagnetic radiation, scattering and diffraction of light (optics). Application to various specific examples. Discussion of the structure of Maxwell's equations, Lorentz invariance, relativity theory and covariance, Lagrangian formulation. Dynamics of relativistic particles in the presence of fields and their radiation properties (synchrotron).

**Literature**

J.D. Jackson, Classical Electrodynamics
W.K.H Panovsky and M. Phillips, Classical electricity and magnetism
A. Sommerfeld, Elektrodynamik, Optik (Vorlesungen über theoretische Physik)
M. Born and E. Wolf, Principles of optics
R. Feynman, R. Leighton, and M. Sands, The Feynman Lectures of Physics, Vol II

**Notice**

- Mind the enrolment deadlines at UZH:
- No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
  - UZH Module Code: IN1701
- http://stoop.ini.uzh.ch/teaching/seminar-on-auditory-informatics

- Mind the enrolment deadlines at UZH:
- Invited talks on current research from the following areas: Auditory information processing, auditory sensors (biological and electrical), coding of information, perception, scene-segmentation.
- Exchange with researchers in the domain of auditory informatics. Preparing and giving a presentation on a suitable topic in front of a scientific audience.

- The semester program is available under:
  - http://stoop.ini.uzh.ch/teaching/seminar-on-auditory-informatics

- On request the "Lehrsprache" may be changed to German.

- No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
  - UZH Module Code: IN1413

- Mind the enrolment deadlines at UZH:
  
- Studium aktueller und klassischer Arbeiten der glaziologischen Forschung

- Studium aktueller und klassischer Arbeiten der glaziologischen Forschung
  - benötigte Unterlagen werden im Verlauf der Veranstaltung abgegeben
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
the course gives an introduction into fundamental techniques and algorithms of numerical mathematics which play a central role in numerical simulations in science and technology. The course focuses on fundamental ideas and algorithmic aspects of numerical methods. The exercises involve actual implementation of numerical methods in C++.

Objective
* Knowledge of the fundamental algorithms in numerical mathematics
* Knowledge of the essential terms in numerical mathematics and the techniques used for the analysis of numerical algorithms
* Ability to choose the appropriate numerical method for concrete problems
* Ability to interpret numerical results
* Ability to implement numerical algorithms efficiently

Content
1. Direct Methods for linear systems of equations
2. Least Squares Techniques
3. Data Interpolation and Fitting
4. Filtering Algorithms
8. Approximation of Functions
9. Numerical Quadrature
10. Iterative Methods for non-linear systems of equations
11. Single Step Methods for ODEs
12. Stiff Integrators

Lecture notes
Lecture materials (PDF documents and codes) will be made available to participants.

Literature


M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002

P. Deuflhard and A. Hohmann, "Numerische Mathematik I", DeGruyter, 2002

Prerequisites / notice
Solid knowledge about fundamental concepts and techniques from linear algebra & calculus as taught in the first year of science and engineering curricula.

The course will be accompanied by programming exercises in C++ relying on the template library EIGEN. Familiarity with C++, object oriented and generic programming is an advantage. Participants of the course are expected to learn C++ by themselves.

Physics Master - Key for Type

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<thead>
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<tbody>
<tr>
<td>W</td>
<td>Dr</td>
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<tr>
<td>E-</td>
<td>O</td>
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Courses outside the curriculum

Suitable for doctorate
Compulsory

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<td>U</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
</tr>
</tbody>
</table>

P practical/laboratory course
A independent project
D diploma thesis
R revision course / private study

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Students in the Joint Degree Master's Programme “Quantitative Finance” must book UZH modules directly at the UZH. Those modules are not listed here.

► Core Courses

►► Economic Theory for Finance

For possible additional course offerings see www.msfinance.ch

►► Mathematical Methods for Finance

For possible additional course offerings see www.msfinance.ch

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3913-01L</td>
<td>Mathematical Foundations for Finance</td>
<td>W</td>
<td>4</td>
<td>3V+2U</td>
<td>E. W. Farkas, M. Schweizer</td>
</tr>
</tbody>
</table>

Abstract
First introduction to main modelling ideas and mathematical tools from mathematical finance

Objective
This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

Content
Topics to be covered include

- financial market models in finite discrete time
- absence of arbitrage and martingale measures
- valuation and hedging in complete markets
- basics about Brownian motion
- stochastic integration
- stochastic calculus: Itô’s formula, Girsanov transformation, Itô’s representation theorem
- Black-Scholes formula

Lecture notes
Lecture notes will be sold at the beginning of the course.

Literature
Lecture notes will be sold at the beginning of the course. Additional (background) references are given there.

Prerequisites / notice
Prerequisites: Results and facts from probability theory as in the book “Probability Essentials” by J. Jacod and P. Protter will be used freely. Especially participants without a direct mathematics background are strongly advised to familiarise themselves with those tools before (or very quickly during) the course. (A possible alternative to the above English textbook are the (German) lecture notes for the standard course “Wahrscheinlichkeitsrechnung.”)

For those who are not sure about their background, we suggest to look at the exercises in Chapters 8, 9, 22-25, 28 of the Jacod/Protter book. If these pose problems, you will have a hard time during the course. So be prepared.

► Elective Courses

►► Economic Theory for Finance

For possible additional course offerings see www.msfinance.ch

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tr>
<td>401-4633-00L</td>
<td>Data Analytics in Organisations and Business</td>
<td>W</td>
<td>5</td>
<td>2V+1U</td>
<td>I. Flückiger</td>
</tr>
</tbody>
</table>

Abstract
On the end-to-end process of data analytics in organisations & business and how to transform data into insights for fact based decisions. Presentation of the process from the beginning with framing the business problem to presenting the results and making decisions by the use of data analytics. For each topic case studies from the financial service, healthcare and retail sectors will be presented.

Objective
The goal of this course is to give the students the understanding of the data analytics process in the business world, with special focus on the skills and techniques used besides the technical skills. The student will become familiar with the “business language”, current problems and thinking in organisations and business and tools used.

Content
Framing the Business Problem
Framing the Analytics Problem
Data
Methodology
Model Building
Deployment
Model Lifecycle

Lecture notes
Lecture Notes will be available.

Prerequisites / notice
Prerequisites: Basic statistics and probability theory and regression

►► Mathematical Methods for Finance

For possible additional course offerings see www.msfinance.ch

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-3925-00L</td>
<td>Non-Life Insurance: Mathematics and Statistics</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>M. V. Wüthrich</td>
</tr>
</tbody>
</table>

Abstract
The lecture aims at providing a basis in non-life insurance mathematics which forms a core subject of actuarial sciences. It discusses collective risk modeling, individual claim size modeling, approximations for compound distributions, ruin theory, premium calculation principles, tariffication with generalized linear models, credibility theory, claims reserving and solvency.

Objective
The student is familiar with the basics in non-life insurance mathematics and statistics. This includes the basic mathematical models for insurance liability modeling, pricing concepts, stochastic claims reserving models and ruin and solvency considerations.
Content
The following topics are treated:
Collective Risk Modeling
Individual Claim Size Modeling
Approximations for Compound Distributions
Ruin Theory in Discrete Time
Premium Calculation Principles
Tariffication and Generalized Linear Models
Bayesian Models and Credibility Theory
Claims Reserving
Solvency Considerations

Lecture notes
M. V. Wüthrich, Non-Life Insurance: Mathematics & Statistics
http://ssrn.com/abstract=2319328

Prerequisites / notice
The exams ONLY take place during the official ETH examination period.
This course will be held in English and counts towards the diploma of "Aktuar SAV". For the latter, see details under www.actuaries.ch.
Prerequisites: knowledge of probability theory, statistics and applied stochastic processes.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Lecturer</th>
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<tr>
<td>401-4889-00L</td>
<td>Mathematical Finance</td>
<td>11</td>
<td>W</td>
<td>M. Schweizer</td>
</tr>
<tr>
<td>401-4657-00L</td>
<td>Numerical Analysis of Stochastic Ordinary Differential Equations</td>
<td>6</td>
<td>W</td>
<td>A. Jentzen</td>
</tr>
<tr>
<td>401-3929-00L</td>
<td>Financial Risk Management in Social and Pension Insurance</td>
<td>4</td>
<td>W</td>
<td>P. Blum</td>
</tr>
</tbody>
</table>

Abstract
401-4889-00L
Advanced introduction to mathematical finance:
- absence of arbitrage and martingale measures
- option pricing and hedging
- optimal investment problems
- additional topics

Objective
Advanced level introduction to mathematical finance, presupposing knowledge in probability theory and stochastic processes.

Content
This is an advanced level introduction to mathematical finance for students with a good background in probability. We want to give an overview of main concepts, questions and approaches, and we do this in both discrete- and continuous-time models. Topics include absence of arbitrage and martingale measures, option pricing and hedging, optimal investment problems, and probably others.
Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

Lecture notes
None available

Literature
Details will be announced in the course.
Prerequisites / notice
Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

Abstract
401-4657-00L
Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

Objective
The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Content
Generation of random numbers
Monte Carlo methods for the numerical integration of random variables
Stochastic processes and Brownian motion
Stochastic ordinary differential equations (SODEs)
Numerical approximations of SODEs
Multilevel Monte Carlo methods for SODEs
Applications to computational finance: Option valuation

Lecture notes
Lecture Notes are available in the lecture homepage (please follow the link in the Learning materials section).

Literature
P. Glassermann:
Monte Carlo Methods in Financial Engineering.

P. E. Kloeden and E. Platen:
Numerical Solution of Stochastic Differential Equations.

Prerequisites / notice
Mandatory: Probability and measure theory, basic numerical analysis and basics of MATLAB programming.

a) mandatory courses:
Elementary Probability, Probability Theory I.

b) recommended courses:
Stochastic Processes.

Start of lectures: Wednesday, September 21, 2016
For more details, please follow the link in the Learning materials section.

Abstract
401-3929-00L
Investment returns are an important source of funding for social and pension insurance, and financial risk is an important threat to stability.
We study short-term and long-term financial risk and its interplay with other risk factors, and we develop methods for the measurement and management of financial risk and return in an asset/liability context with the goal of assuring sustainable funding.
Understand the basic asset-liability framework: essential principles and properties of social and pension insurance; cash flow matching, duration matching, valuation portfolio and loose coupling; the notion of financial risk; long-term vs. short-term risk; coherent measures of risk.

Understand the conditions for sustainable funding: derivation of required returns; interplay between return levels, contribution levels and other parameters; influence of guaranteed benefits.

Understand the notion of risk-taking capability: capital process as a random walk; measures of long-term risk and relation to capital; short-term solvency vs. long-term stability; effect of embedded options and guarantees; interplay between required return and risk-taking capability.

Be able to study empirical properties of financial assets: the Normal hypothesis and the deviations from it; statistical tools for investigating relevant risk and return properties of financial assets; time aggregation properties; be able to conduct analysis of real data for the most important asset classes.

Understand and be able to carry out portfolio construction: the concept of diversification; limitations to diversification / correlation breakdown / what happened in 2008; the Kuhn-Tucker Theorem and optimization (mean-variance, mean-downside); incorporation of constraints; sensitivity and shortcomings of optimized portfolios.

Understand and interpret the asset-liability interplay: the optimized portfolio in the asset-liability framework; short-term risk vs. long-term risk; the influence of constraints; feasible and non-feasible solutions; practical considerations.

Know about active portfolio management: practical issues when implementing an investment strategy; the notion of active management; efficient markets hypothesis and limitations to it; empirical evidence; the fundamental law of active management; Bayesian concepts and the Black-Litterman framework.

Have an overall view: see the big picture of what asset returns can and cannot contribute to social security; be aware of the most relevant outcomes; know the role of the actuary in the financial risk management process.

For pension insurance and other forms of social insurance, investment returns are an important source of funding. In order to earn these returns, substantial financial risks must be taken, and these risks represent an important threat to financial stability, in the long term and in the short term.

Risk and return of financial assets cannot be separated from one another and, hence, asset management and risk management cannot be separated either. Managing financial risk in social and pension insurance is, therefore, the task of reconciling the contradictory dimensions of

1. Required return for a sustainable funding of the institution,
2. Risk-taking capability of the institution,
3. Returns available from financial assets in the market,
4. Risks incurred by investing in these assets.

This task must be accomplished under a number of constraints. Financial risk management in social insurance also means reconciling the long time horizon of the promised insurance benefits with the short time horizon of financial markets and financial risk.

It is not the goal of this lecture to provide the students with any cookbook recipes that can readily be applied without further reflection. The goal is rather to enable the students to develop their own understanding of the problems and possible solutions associated with the management of financial risks in social and pension insurance.

To this end, a rigorous intellectual framework will be developed and a powerful set of mathematical tools from the fields of actuarial mathematics and quantitative risk management will be applied. When analyzing the properties of financial assets, an empirical viewpoint will be taken using statistical tools and considering real-world data.

Since this is the first instance of this course, there is not yet a full script. However, to complement the blackboard notes, extensive handouts will be provided. Moreover, practical examples and data sets in Excel and Octave / Matlab will be made available to play around with and deepen the understanding of the subject matter.

This task must be accomplished under a number of constraints. Financial risk management in social insurance also means reconciling the long time horizon of the promised insurance benefits with the short time horizon of financial markets and financial risk.

This course counts towards the diploma of "Aktuar SAV".

The exams ONLY take place during the official ETH examination period.

<table>
<thead>
<tr>
<th>401-3922-00L</th>
<th>Life Insurance Mathematics</th>
<th>W</th>
<th>4 credits</th>
<th>2V</th>
<th>M. Koller</th>
</tr>
</thead>
</table>

**Abstract**

The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and endowment insurance and disability). Besides that the most important terms such as mathematical reserves are introduced and calculated. The profit and loss account and the balance sheet of a life insurance company is explained and illustrated.

**Master's Thesis**

[see www.oec.uzh.ch/studies/general/theses/oec_en.html](http://www.oec.uzh.ch/studies/general/theses/oec_en.html)

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**Quantitative Finance Master - Key for Type**

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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### Key for Hours

<table>
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<td>U</td>
<td>exercise</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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**ECTS**

- European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Spatial Development and Infrastructure Systems Master

1. Semester

Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
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<tr>
<td>101-0467-01L</td>
<td>Transport Systems</td>
<td>O</td>
<td>6 credits</td>
<td>4G</td>
<td>U. A. Weidmann, K. W. Axhausen, M. Menendez, M. Sinner</td>
</tr>
<tr>
<td>103-0317-00L</td>
<td>Sustainable Spatial Development I</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>B. Scholl</td>
</tr>
<tr>
<td>103-0347-01L</td>
<td>Landscape Planning and Environmental Systems</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>A. Grêt-Regamey</td>
</tr>
</tbody>
</table>

Abstract

History, impact and principles of the design and operation of transport systems

Introduction of the basic principles of the design and operation of transport systems (road, rail, air) and of the essential pathways of their impacts (investment, generalised costs, accessibilities, external effects)

Transport systems and land use; network design; fundamental model of mobility behaviour; costs and benefits of mobility; transport history

Network layout and its impact on road traffic. Traffic control systems for urban and inter-urban areas. Fundamentals of road safety and infrastructure maintenance.

The lectures imparts important knowledge for solving spatial relevant conflicts and problems. Case studies will be used to demonstrate the implementation in practice.

Spatial development deals with the development and the design of our living space. To meet the expectations, the interests and the plans of the different actors, it is needed a planning approach considering the overview of both the actual and future situation.

Spatial planning as an integral information system for the coordination of different instruments by illustrating the aims, systems (soil, water, air, climate, flora and fauna).

Tasks of Spatial Planning and development
Issues of local and supra-local interest
Recurring spatial changes, impacts and key figures
Formal and informal instruments and procedures in spatial planning
Spatial Design - Ideas about the future
Reasoning and assessing the situation in spatial planning
Spatial planning as a sequence of decisions and interventions
Process and procedures management
Focus issues - Inner development before external development
Focus issues - Cross-border tasks
Focus Issues - Integrated spatial and infrastructure development

Lecture notes

Lecturer notes and slides as well as hints to further literature will be given during the course.

Obligatory lecture for students of the first semester of MSc Spatial Development and Infrastructure Systems.

Remark: parts of the lecture will be given in German.

Lecture notes

Futher information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.

Obligatory lecture for students of the first semester of MSc Spatial Development and Infrastructure Systems.

Remarks: parts of the lecture will be given in German.

Prerequisites / notice

No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.

The contents of the course will be illustrated in the associated lecture 103-0347-01 U (Landscape Planning and Environmental Systems (GIS Exercises)). An combination of courses is recommended.

Major Courses

Major in Spatial Development
In order to solve problems in spatial planning it is necessary to explore actions and to judge them; finally, one has to argue why a certain decision depends upon the preferences of the deciding acteur. They are also familiar with difficulties and pitfalls within these contexts and know what can be done against it. Assessments of the situation are the basis for the problems to treat. Specific knowledge, represented by the lecturer is required.

The subjects are:
- Site and market analysis
- Real estate development
- Project development from the perspective of project developers and investors
- Parking and transportation models
- Cooperative planning, participation processes, mediation

The lecture consists of several modules. The main focus is on site and project development questions in relation to recycling of industrial wasteland. Technical presentations, lectured by scientific staff of the division of Planning of Landscape and Urban Systems PLUS as well as well guest referees treat different subjects.

The theory is discussed and illustrated at case studies and exercises. Specific large-scale projects that are currently in the development phase will be discussed, for example the area Sihl- Manegg in Zurich (GreenCity) or the area Alter Pilatusmarkt (Niedfeld) Luzern. For one specific industrial wasteland area the students will develop a vision for a possible redevelopment and a new land-use concept, which will be discussed with experts.

Objectives of the lecture are:
- The participants know the interdependencies between the assessment of a situation, decision making, knowledge and language. They know what can be done against it.
- They know the nature of a decision dilemma and maximes, how to deal with it. Especially they learn that the requirement of information for a decision depends upon the preferences of the deciding acteur. They are also familiar with difficulties and pitfalls within these contexts and know what can be done against it.

Lecture notes
- Handouts of the lectures
- Extracts from relevant scientific articles and theory literature
- Exercise material

Download: http://www.irl.ethz.ch/plus/education

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0337-00L</td>
<td>Site and Project Development</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>G. Nussbaumer</td>
</tr>
<tr>
<td>Abstract</td>
<td>The main focus of the lecture is on site and project development questions in relation to recycling of industrial wasteland. A semester exercise covers a specific major project and serves as the semester grade (project report and presentation).</td>
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<tr>
<td>Objective</td>
<td>Objectives of the lecture are: 1) Get knowledge of comprehensive and multifunctional large-scale projects and their problem areas 2) Get deepened knowledge in selected fields (site analysis, market analysis, project development, cooperative planning, participation processes) 3) Practical assessment, insight into occupational fields 4) Independent acquisition and acquisition of theoretical knowledge</td>
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<tr>
<td>Content</td>
<td>The lecture consists of several modules. The main focus is on site and project development questions in relation to recycling of industrial wasteland. Technical presentations, lectured by scientific staff of the division of Planning of Landscape and Urban Systems PLUS as well as guest referees treat different subjects.</td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>103-0417-02L</td>
<td>Theory and Methodology of Spatial Planning</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Nollert</td>
</tr>
<tr>
<td>Abstract</td>
<td>In order to solve problems in spatial planning it is necessary to explore actions and to judge them; finally, one has to argue why a certain option should be preferred to others. Assessments of the situation are the basis for the problems to treat. Specific knowledge, represented in an adequate manner, is required.</td>
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<tr>
<td>Objective</td>
<td>The participants know the interdependencies between the assessment of a situation, decision making, knowledge and language. They know the nature of a decision dilemma and maximes, how to deal with it. Especially they learn that the requirement of information for a decision depends upon the preferences of the deciding acteur. They are also familiar with difficulties and pitfalls within these contexts and know what can be done against it.</td>
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<tr>
<td>Content</td>
<td>Assessment of the situation, deciding, language and knowledge are the main parts.</td>
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0363-00L</td>
<td>History of Urban Design I</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>V. Magnago Lampugnani</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture covers the time from the beginning of urban culture until the mid 19th century. With selected examples it emphasizes on the historical plannings and methods of European cities. Each specific urban development will be presented within a broader context.</td>
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<tr>
<td>Objective</td>
<td>This course analyzes the history of urban architecture primarily in its existing three dimensional form as a complex human artefact. It also explores the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach, such as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.</td>
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<tr>
<td>Content</td>
<td>In the first semester an introduction to the discipline and the methods are given along the thematic issues from the beginning of urban culture until the mid-19th century.</td>
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</tbody>
</table>

- Exercise material
- Extracts from relevant scientific articles and theory literature
- Lecture notes
- Historical plannings and methods of European cities
- Guest referees treat different subjects.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Schedule</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0707-00L</td>
<td>Space Planning Law and Environment</td>
<td>2</td>
<td>W</td>
<td>O. Bucher</td>
</tr>
<tr>
<td>103-0327-00L</td>
<td>History of Spatial Planning</td>
<td>1</td>
<td>1V</td>
<td>M. Koll-Schretzenmayr</td>
</tr>
<tr>
<td>103-0569-00L</td>
<td>European Aspects of Spatial Development</td>
<td>3</td>
<td>2G</td>
<td>A. Peric Momcilovic</td>
</tr>
</tbody>
</table>

**Abstract**

- **Space Planning Law and Environment**
  - Particularly suitable for students of D-ARCH, D-BAUG, D-USYS
  - System of swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, Instruments, Application, legal protection, enforcement, Practical training.

**Objective**

- Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.

**Content**


**Lecture notes**


**Abstract**

- The course examines the patterns of cleavage, conflict, convergence of interest, and consensus that have structured spatial planning.

**Objective**

- This course aims to provide students with knowledge of the historical background to understand the current spatial structure and to face the current challenges in spatial planning.

**Content**

- Die Veranstaltung gibt einen Überblick über die Geschichte der Raumplanung. Sie möchte das Verständnis für die Ideengeschichte wecken und den historischen Kontext für die gegenwärtige Raumplanung und Raumstruktur vermitteln.

**Literature**

- Kleine Geschichte der Schweiz: Der Bundesstaat und seine Traditionen (edition suhrkamp)
- Daniel Kurz: Die Disziplinierung der Stadt - Moderner Städtebau in Zürich 1900 bis 1940. gta Verlag 2008

**Abstract**

- Following the insight into historical perspective and contemporary models of governance and planning, the course focuses on the international dimension of spatial planning in Europe. This includes a discussion of how European spatial policy is made and by whom, how planners can participate in such process and how they can address transnational challenges of spatial development cooperatively.

**Objective**

- Keeping the general aim of exploring the European dimension of spatial planning in mind, the specific course learning objectives are as follows:
  - to interpret the history of spatial planning at the transnational scale
  - to understand and explain the content of the European spatial policy agenda
  - to analyze the role of territorial cooperation in making European spatial development patterns and planning procedures
  - to discuss the changing role of planners and evaluate the ways of their engagement in European spatial policy-making

**Content**

- European spatial policy agenda: introduction and basic directives
- governance models
- planning models; collaborative planning model (main concepts & critics)
- post-positivist approach to spatial planning
- transnational spatial planning in Europe; questioning the European spatial planning; spatial development trends in Europe
- EU as a political system: EU institutions & non-EU actors
- planning families in Europe; the European spatial planning agenda
- to describe and analyse the role of territorial cooperation
- the notion of planning culture and planning system; planning cultures in Europe
- basic characteristics of planning systems in Europe
- to discuss the changing role of planners and evaluate the ways of their engagement in European spatial policy-making
- European transnational cooperation for spatial planning
- European transnational initiatives: CODE 24 (Rotterdam-Genoa); Orient/east-Med corridor (Hamburg-Athens), Danube region

**Lecture notes**

- The documents for the lecture will be provided at the moodle, https://moodle-app2.let.ethz.ch/course/view.php?id=2298.
The course content of the lecture Landscape Planning and Environmental Systems (103-0347-00 V) will be illustrated.

Planning systems in Europe:

Prerequisites
Only for master students, otherwise a special permission by the lecturer is required.

### Major in Landscape and Environmental Planning

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>103-0307-00L</td>
<td>Multi-Criteria Decision Analysis</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Grêt-Regamey</td>
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<td></td>
<td>Planners need to make decisions about the best possible mix of land uses. With increasing availability of spatial databases and the analytical capabilities of GIS, more effective decision support systems can be developed. The goal of the course is to provide the basics of spatial analysis and to teach the integration of spatial data into multicriteria decision-making systems.</td>
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<td><strong>Objective</strong></td>
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<td>This course will:</td>
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<tr>
<td></td>
<td>1) introduce students to techniques and issues associated with spatial modeling and decision support systems, including analytical techniques that are unique to spatial analysis</td>
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<td>2) provide hands-on training in the use of these spatial tools in R while addressing real planning problems.</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<tr>
<td></td>
<td>- Handouts of the lectures</td>
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<td>- Script</td>
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<td>- Exercise material</td>
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<td></td>
<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>Download: <a href="http://www.irt.ethz.ch/plus/education">http://www.irt.ethz.ch/plus/education</a></td>
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<td>The course will be held in German and English. It is highly recommended to attend the lecture &quot;Introduction to the data analysis software R&quot; (&quot;Einführung in die R Umgebung für Datenanalyse&quot;), providing the basic principles of using the R-Software.</td>
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<table>
<thead>
<tr>
<th>103-0347-01L</th>
<th>Landscape Planning and Environmental Systems (GIS W Exercises)</th>
<th>W</th>
<th>3</th>
<th>2U</th>
<th>A. Grêt-Regamey, S. Huber, S.E. Rabe, A. Strith</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The course content of the lecture Landscape Planning and Environmental Systems (103-0347-00 V) will be illustrated.</td>
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<td><strong>Abstract</strong></td>
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<td>The course content of the lecture Landscape Planning and Environmental Systems (103-0347-00 V) will be illustrated.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>To show the importance of ecosystem services.</td>
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<td>Analysis and assessment of the complex interactions between landscape elements.</td>
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<td>To identify and measure the characteristics of landscape.</td>
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<td>Learn how to use the instrument of GIS appropriately in landscape planning.</td>
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<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>- Environmental systems, IUCN Red List, ecological connectivity</td>
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<td></td>
<td>- Calculating urban landscape services</td>
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<td></td>
<td>- Practice of landscape planning</td>
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<tr>
<td></td>
<td>- Use of GIS in landscape planning</td>
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<td>- Modelling</td>
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<td>- Landscape analysis</td>
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<td></td>
<td>- Landscape metrics</td>
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<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
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<tr>
<td></td>
<td>No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<tr>
<td></td>
<td>Basic GIS skills are recommended. A brief introduction to GIS will be given in the first exercise.</td>
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<tr>
<td>851-0707-00L</td>
<td>Space Planning Law and Environment</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>O. Bucher</td>
</tr>
<tr>
<td></td>
<td>Particularly suitable for students of D-ARCH, D-BAUG, D-</td>
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</table>

**Autumn Semester 2016**
Introduction to the history and theory of garden design and landscape architecture. Analysis of the design of historical gardens and landscapes within the cultural background.

Objective
Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.

Content

Lecture notes
Haller, Walter/Karlen, Peter, Raumplanung-, Bau- und Umweltrecht, 3.A., Zürich 1999

Hänni, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, 6.A., Bern 2016

Lecture notes
Handouts and a reading list will be provided.

Literature
A reading list will be provided for the exams.

Prerequisites / notice
General Information for the final exam:
Bachelor students: The content of the lectures as well as texts and exam-relevant literature provided by the Chair make up the basis for preparing for the exam. The lecture series is conceived as a yearlong course. Since the written session examination will test knowledge from both seminars, it is necessary to fully attend the lectures of both courses “Landscape Architecture I” and “Landscape Architecture II".

The themes of the examination will be announced at the end of the semester. The Chair will provide literature and texts available for download as pdfs. These allow a more in-depth understanding of the lecture material.

Exchange students or students from other departments: Students, who are attending only one semester, may pass the oral end-of-semester examination. Test-relevant literature will also be made available for download for this purpose.

The students are requested to get in touch by email with the Chair.
The slides of the lecture are provided electronically. Concepts will be explained step-by-step through a set of case studies, and applied in lab by the students. The following principal steps are used when coping with natural hazard-risks. At each step, students will learn and apply the following skills:

**Objective**

1. **Risk analysis - What can happen?**
   - Characterize the processes and environmental measures that lead to a natural hazard and integrate modeling results of these processes.
   - Identify threats to human life and assets exposed to natural hazards and estimate possible drawbacks or damages.
2. **Risk assessment - What are the acceptable levels of risk?**
   - Apply principles to determine acceptable risks to human life and assets in order to identify locations which should receive added protection.
   - Explain causes for conflicts between risk perception and risk analysis.
3. **Risk management - What steps should be taken to manage risks?**
   - Explain how various hazard mitigation approaches reduce risk.
   - Describe hazard scenarios as a base for adequate dimensioning of control measures.
   - Identify the best alternative from a set of thinkable measures based on an evaluation scheme.

**Content**

The Vorlesung besteht aus folgenden Blöcken:

1. **Einführung ins Vorgehenskonzept (1W)**
2. **Risikoanalyse (6W + Exkursion) mit:**
   - Systemabgrenzung
   - Gefahrenbeurteilung
   - Expositions- und Folgenanalyse
3. **Risikobewertung (2W)**
4. **Risikomanagement (2W + Exkursion)**
5. **Abschlussbesprechung (1W)**

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**701-1453-00L Ecological Assessment and Evaluation**

**Abstract**

The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

**Objective**

Students will be able to:

1. critically consider biological data books and local, regional, and national inventories;
2. evaluate the validity of ecological criteria used in decision making processes;
3. critically appraise the handling of ecological data and criteria used in the process of evaluation;
4. perform an ecological evaluation project from the field survey up to the decision making process.

Powerpoint slides are available on the webpage. Additional documents are handed out as copies.

**Lecture notes**

Basic literature and references are listed on the webpage.

**Literature**

The course structure changes between lecture parts, seminars and discussions. The didactic atmosphere is intended as working group.

Prerequisites for attending this course are skills and knowledge equivalent to those taught in the following ETH courses:
- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbioökologie

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**363-1047-00L Economics of Urban Transportation**

**Abstract**

The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems. The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students develop their own models.

**Objective**

- Knowledge of methods and algorithms commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning

**Content**

The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such planning problems are the estimation of traffic volumes, prediction of estimated utilization of new public transport lines, and evaluation of effects (e.g. change in emissions of a city) triggered by building new infrastructure and changes to operational regulations.

To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

**Lecture notes**

The slides of the lecture are provided electronically.

**Literature**

Abstract
The first part of the course will present some basic principles of transportation economics, applied to the main issues in urban transport policy (e.g. road pricing, public transport tariffs, investment in infrastructure etc.). The second part of the course will consider some case studies where we will apply the tools acquired in the first part to actual policy issues.

Objective
The main objective of this course is to provide students with some basic tools to analyze transport policy decisions from an economic perspective. Can economics help us reduce road congestion problems? Should drivers be asked to pay for using urban roads? Should public transport tariffs depend on how roads are priced? How should the investment in transport infrastructure be financed? These are some of the questions that students should be able to tackle after completing the course.

Content
COURSE OUTLINE (preliminary):

1. Introduction
2. Travel demand:
   a. travel cost and value of time
   b. mode choice
3. Road congestion and first-best pricing
   a. Static congestion model
   b. Dynamic congestion models
   c. Examples: London Congestion Charge, Stockholm Congestion Charge
4. Second-best pricing
   a. Pricing roads with unpriced alternatives: Examples: tolled and toll-free highways
   b. Public transport: pricing with road congestion and with (or without) road tolls
5. Investment in infrastructure: public transport and roads
   a. Roads: Investment with and without pricing
   b. induced demand
   c. Economies of scale/density in public transport
6. Topics:
   a. Political economy of road pricing: why do we see road pricing in so few cities (London, Stockholm…) and not in many other cities (NYC, Manchester, Paris…)?
   b. What are the alternatives to road pricing to reduce congestion? Parking tariffs, traffic regulation (speed bumps, low emission zones), road space reduction. Examples: Zurich, San Francisco (SFpark), Paris.
   c. Transport and land use: value of housing and transport services. Road congestion, transport subsidies and urban sprawl.

Lecture notes
Course slides will be made available to students prior to each class.

Literature
SYLLABUS (preliminary):

course slides will be made available to students.

Additional material:

Part 1 to 5: textbook: Small and Verhoef (The economics of urban transportation, 2007).

Part 6: Topics to be covered on research papers/case studies.

### Major in Transport Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0427-01L</td>
<td>System and Network Planning</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>U. A. Weidmann</td>
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<td></td>
<td>Public transports in the context of the transport systems; customer needs in the transport market; service planning processes for regular public transport services; long distance, regional and urban public transport service strategies; access to public transport and the last mile</td>
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<td>Students will develop a basic knowledge of all stages of the public transport planning process from market demand to service planning; they will understand the most relevant planning methods and will be able to use them</td>
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<td>(1) Fundamentals of system and network planning: Mobility and transport systems; public transport systems; customer needs versus supply characteristics of regular services. (2) System and network planning in public passenger services: Goals of the system and network planning; generic planning process; demarcation, analysis of the situation, setting of targets; design of public transport services; evaluation and optimization; system planning. (3) Public transport services: long distance service offers; suburban and urban service offers; regional and local service offers; access to public transport and the last mile</td>
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<td></td>
<td>A script in German will be provided for the course. The slides are made available.</td>
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<td>Lecture notes</td>
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<tr>
<td>Literature</td>
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<tr>
<td>Prerequisites / notice</td>
<td>No remarks.</td>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>101-0499-00L</td>
<td>Basics in Air Transport</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Wild</td>
</tr>
<tr>
<td></td>
<td>The course explains main principles of air transport in general and elaborates on simple interdisciplinary topics. Since working on broad topics like aerodynamics, manufacturers, airport operation, business aviation, business models etc. the students gets a good overview in air Transportation.</td>
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<td></td>
<td>Understand and explain basics, principles and contexts in the broader air transport industry. Lay the foundation of working in or with the air transport industry.</td>
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<td>Ideal foundation for Aviation II - Management of Air Transport</td>
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<td>Weekly: 1h independent preparation; 2h lectures and 1 h training with an expert in the respective field</td>
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<tr>
<td>Concept</td>
<td>Concept: This course will be taught as Aviation I. A subsequent course is under evaluation.</td>
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<td>Content: Transport as part of the overall transportation scheme; Aerodynamics; Aircraft (A/C) Designs &amp; Structures; A/C Operations; Law Enforcement; Maintenance &amp; Manufacturers; Airport Operations &amp; Planning; Customs &amp; Security; ATC &amp; Airspace; Air Freight; General Aviation; Business Jet Operations; Business models within Airline Industry; Military Operations.</td>
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<td>Technical visit: This course includes a guided tour at Zurich Airport (baggage sorting system, apron, ATC Tower).</td>
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<td>Lecture notes</td>
<td>Slides are provided prior to each class</td>
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<td>Literature</td>
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<td>Prerequisites / notice</td>
<td>Literature</td>
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<td>Notice: References to technical literature will be included in the course script. An additional list of literature will be given during the course.</td>
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### Traffic Engineering

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<tbody>
<tr>
<td></td>
<td>The first part of the course will present some basic principles of transportation economics, applied to the main issues in urban transport policy (e.g. road pricing, public transport tariffs, investment in infrastructure etc.). The second part of the course will consider some case studies where we will apply the tools acquired in the first part to actual policy issues. The main objective of this course is to provide students with some basic tools to analyze transport policy decisions from an economic perspective. Can economics help us reduce road congestion problems? Should drivers be asked to pay for using urban roads? Should public transport tariffs depend on how roads are priced? How should the investment in transport infrastructure be financed? These are some of the questions that students should be able to tackle after completing the course.</td>
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### Traffic Engineering

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</table>
Course slides will be made available to students prior to each class.

ECTS

Fundamentals of traffic flow theory and operations. The first part of the course will present some basic principles of transportation economics, applied to the main issues in urban transport.

COURSE OUTLINE (preliminary):

Introduction to fundamentals of traffic flow theory and operations. Includes understanding of traffic data collection and processing techniques, as well as data analysis, and traffic modeling.

Additional literature recommendations will be provided during the lectures.

Verkehr III - Road Transport Systems 6th Sem. BSc (101-0415-00L)

Special permission from the instructor can be requested if the student has not taken Verkehr III

Energy and Mobility

The lecture Energy and Mobility imparts profound knowledge on how to reduce energy in mobility systems. Both Engineering science and social science aspects are integrated as technological potentials, policy tools, and human decision making behaviour are combined in order to assess how to reduce energy demand for transport.

Abstract

The lecture Energy and Mobility deals with the intersection of energy and transportation with focus on motorized individual transport. The lecture deals with the question, how the energy demand, or greenhouse gas emissions, of mobility can be reduced. A five step approach provides a common framework:

1. Introduction
2. Travel demand:
   a. travel cost and value of time
   b. mode choice
3. Road congestion and first-best pricing
   a. Static congestion model
   b. Dynamic congestion models
   c. Examples: London Congestion Charge, Stockholm Congestion Charge
4. Second-best pricing
   a. Pricing roads with unpriced alternatives. Examples: tolled and toll-free highways
   b. Public transport: pricing with road congestion and with (or without) road tolls
5. Investment in infrastructure: public transport and roads
   a. Roads: Investment with and without pricing
   b. induced demand
   c. Economies of scale/density in public transport
6. Topics:
   a. Political economy of road pricing: why do we see road pricing in so few cities (London, Stockholm...) and not in many other cities (NYC, Manchester, Paris...)?
   b. What are the alternatives to road pricing to reduce congestion? Parking tariffs, traffic regulation (speed bumps, low emission zones), road space reduction. Examples: Zurich, San Francisco (SFPark), Paris.
   c. Transport and land use: value of housing and transport services. Road congestion, transport subsidies and urban sprawl.

Lecture notes

Course slides will be made available to students prior to each class.

SYLLABUS (preliminary):

course slides will be made available to students.

Additional material:

Part 1 to 5: textbook: Small and Verhoef (The economics of urban transportation, 2007).

Part 6: Topics to be covered on research papers/case studies.

Infrastructure Management

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<tbody>
<tr>
<td>101-0579-00L</td>
<td>Infrastructure Maintenance Processes</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>B. T. Adey</td>
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</table>

101-0579-00L "Infrastructure Maintenance Processes" will be offered from FS17 on with new title 101-0579-00L
"Infrastructure Management 2: Evaluation Tools".

Abstract
This course provides an introduction to the tools that can be used to evaluate infrastructure. In particular tools:
- to measure the level of service being obtained from infrastructure,  
- to predict slow changes in infrastructure over time, and
- to predict fast changes in infrastructure over time, fits of monitoring.

Objective
To equip students with tools to be used to evaluate infrastructure and the level of service being provided from infrastructure.

Content
Introduction
Levels of service
Reliability of infrastructure
Availability and maintainability of infrastructure
Mechanistic-empirical models
Regression analysis
Event trees
Fault trees
Markov chains
Neural networks
Bayesian networks
Conclusion

Literature
All necessary materials (e.g. transparencies and hand-outs) will be distributed before class.

Appropriate reading material will be assigned when necessary.

101-0187-00L Structural Reliability and Risk Analysis W 3 credits 2G  B. Sudret

Abstract
Structural reliability aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing and environmental conditions. Risk analysis combines this information with the consequences of failure in view of optimal decision making. The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment.

Objective
The goal of this course is to provide students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field.

Content
Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro-codes usually provide a framework that guarantees safety and reliability. However the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FORM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented.

Lecture notes
Slides of the lectures are available online every week. A printed version of the full set of slides is proposed to the students at the beginning of the semester.

Literature

S. Marelli, R. Schöbi, B. Sudret, UQLab user manual - Structural reliability (rare events estimation), Report UQLab-V0.92-107.

Prerequisites / notice
Basic course on probability theory and statistics
Introduction to the Data Analysis Software R

Abstract
R is one of the most popular statistical open-source software for data analysis and data modeling. It has proved very useful for a variety of tasks commonly faced by planners, such as data preparation, exploratory analysis, model estimation or graphical display. R is also a programming language providing users with a more flexible and powerful tool for solving more complex problems.

Objective
The aim of this course is to provide participants with an introduction to the statistical open-source software R. Students will learn how to read data from files and write data to files, and how these data can be used to plot graphs and maps. Since R is a command-line software, that is, one has to type in text commands at a prompt, rather than just clicking menus and buttons, students will also learn how to write their own functions.

Content
- Reading data from files
- Creating and handling R objects such as matrices, vectors and arrays
- Plotting data: histograms, boxplots, scattered plots
- Writing data to files
- Reading raster and vector data
- Writing for- and while-loops
- Writing your own functions

Prerequisites
The course will be held in English and no prior knowledge on R is required.

Literature
"Introduction to R" by W. N. Venables and D. M. Smith available online at http://cran.r-project.org/doc/manuals/R-intro.pdf

Urban and Spatial Economics

Abstract
This course explores the economic factors which influence location decisions of households and firms, and it explores theories of how these decisions induce the formation of cities. The course will cover the neoclassical models of land use, concepts from the new economic geography, zoning, and transportation and traffic congestion.

Objective
The objective of the course is to provide graduate students with an understanding of the economic factors which give rise to urban spatial structure and the models which have been employed to study these processes. The course aims to help students develop an appreciation for the use of economic models in both positive and normative frameworks. We will assess both the history of thought regarding the role of markets in creating urban development, and we will read about modern theories of externalities and economic factors which induce agglomeration. The final section of the course will focus on transportation problems in urban areas and the use of economic models to assess public policy measures to deal with congestion and associated externalities.

Content
- Outline of Lectures
  - Topic 1: Why do cities exist?
  - Topic 2: The Basic Muth-Mills model
  - Topic 3: The New Economic Geography
  - Topic 4: Business demand for land and Von Thünen's model
  - Topic 5: Urban spatial structure
  - Topic 6: Land use control
  - Topic 7: City size and city growth
  - Topic 8: Traffic externalities and congestion
  - Topic 9: Public transport

Lecture notes
Textbook
- Cities, agglomeration and spatial equilibrium by E. L. Glaeser, 2008, Oxford University Press.
- The new introduction to geographical economics, Steven Brakman, Harry Garretsen and Charles van Marrewijk, Cambridge.

3. Semester

Major Courses

Major in Spatial Development

Major in Landscape and Environmental Planning
The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, initiation of erosion as well as sediment transport (bed load, suspended load) are treated. In the second part of the lecture, the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formation and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of channel stability, bed forms, river morphology and scour. The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics focussed on are the stabilization of banks and of the longitudinal profile of rivers.

### Major in Transport Planning

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<tbody>
<tr>
<td>101-0439-00L</td>
<td>Introduction to Economic Analysis - A Case Study</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>K. W. Axhausen, R. Schubert</td>
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<td>Approach with Cost Benefit Analysis in Transport</td>
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<tr>
<td>Abstract</td>
<td>The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive the monetary values of non-market goods.</td>
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<tr>
<td>Objective</td>
<td>Familiarity with the essential methods of project appraisal</td>
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<tr>
<td>Content</td>
<td>Cost-Benefit-Analysis; multi-criteria analysis; European guidelines; stated response methods; travel cost approach and others; Valuation of travel time savings; valuation of traffic safety</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts</td>
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**Production and Operations Management**

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<tbody>
<tr>
<td>363-0445-00L</td>
<td>Production and Operations Management</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>T. Netland, P. Schönsleben</td>
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<tr>
<td>Abstract</td>
<td>This core course on Production and Operations Management provides the students insights into the basic theories, concepts, and techniques used to design, analyze, and improve the operational capabilities of an organization.</td>
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<tr>
<td>Objective</td>
<td>Students learn why and how operations can be a competitive weapon; how to design, plan, control, and manage production and service processes; how to improve effectiveness and efficiency in operations; how to take advantage of new technological advancements; and how environmental and social concerns affect decisions in global production networks.</td>
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<tr>
<td>Content</td>
<td>The course covers the most fundamental strategic and tactical concepts in production and operations management. The lectures cover: Introduction to POM; Operations strategy; Capacity management; Production planning and control; Production philosophies; Lean management; Performance measurement; Problem solving; Service operations; New technologies in POM; Servitization; Global production; and Triple-bottom line.</td>
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**Agent Based Modeling in Transportation**

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<tbody>
<tr>
<td>101-0491-00L</td>
<td>Agent Based Modeling in Transportation</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>F. Ciarl, M. Balac</td>
</tr>
<tr>
<td>Abstract</td>
<td>The main topics of the lecture are: 1) Introduction to the agent-based paradigm and overview on existing agent-based models in transportation, including MATSim 2) Learn how to setup MATSim for policy analysis 3) Learn about the interfaces available to enhances the software (includes Java programming) 4) Create, run and analyze a policy study</td>
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<tr>
<td>Objective</td>
<td>The objective of this course is to make the students familiar with agent-based models and in particular with the software MATSim. They will learn the pros and cons of this type of approach versus traditional transport models and will learn to use the simulation. They will design a policy study and run simulations to evaluate the impacts of the proposed policies.</td>
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<tr>
<td>Content</td>
<td>The main topics are: 1) Introduction to the agent-based paradigm and overview on existing agent-based models in transportation, including MATSim 2) Introduction of basic building blocks of simulation approaches (random numbers generation, experimental design, variance control, response surface estimation) 3) Revision of the key submodels and their parameters and concepts (value of time, Wardrop (Nash) equilibrium, etc.) 4) Learn how to setup MATSim for policy analysis 4) Learn about the interfaces available to enhances the software (includes Java programming) 5) Create, run and analyse a policy study</td>
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Additional relevant readings, mostly scientific articles, will be recommended throughout the course.

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<td>3</td>
<td>2U</td>
<td>F. Ciarl, M. Balac</td>
</tr>
<tr>
<td>Abstract</td>
<td>There are no strict preconditions in terms of which lectures the students should have previously attended. However, it is expected that the students have some experience with some high level programming language (i.e. C, C++, Fortran or Java). If this is not the case, attending the additional java exercises (101-0491-00U) is strongly encouraged.</td>
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**Additional cases to course 363-0445-00 Production and Operations Management.**

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**The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive the monetary values of non-market goods.**

---

**Students learn why and how operations can be a competitive weapon; how to design, plan, control, and manage production and service processes; how to improve effectiveness and efficiency in operations; how to take advantage of new technological advancements; and how environmental and social concerns affect decisions in global production networks.**

---

**The course covers the most fundamental strategic and tactical concepts in production and operations management. The lectures cover: Introduction to POM; Operations strategy; Capacity management; Production planning and control; Production philosophies; Lean management; Performance measurement; Problem solving; Service operations; New technologies in POM; Servitization; Global production; and Triple-bottom line.**

---

**The objective of this course is to make the students familiar with agent-based models and in particular with the software MATSim. They will learn the pros and cons of this type of approach versus traditional transport models and will learn to use the simulation. They will design a policy study and run simulations to evaluate the impacts of the proposed policies.**

---

**The main topics of the lecture are: 1) Introduction to the agent-based paradigm and overview on existing agent-based models in transportation, including MATSim 2) Learn how to setup MATSim for policy analysis 3) Learn about the interfaces available to enhances the software (includes Java programming) 4) Create, run and analyse a policy study**

---

**There are no strict preconditions in terms of which lectures the students should have previously attended. However, it is expected that the students have some experience with some high level programming language (i.e. C, C++, Fortran or Java). If this is not the case, attending the additional java exercises (101-0491-00U) is strongly encouraged.**
JAVA Exercises
Recommended for students without JAVA skills in addition to LE101-0491-00 Agent Based Modeling in Transportation.

Abstract
This course provides the basic concepts of high level programming languages to students without previous programming training. The language used is Java. Since this course is preparatory for the course Agent Based Modeling in Transportation, the same simulation software, MATSim, will be used for several exercises.

Objective
The objective of this course is to make the students familiar with some basic concepts of object oriented programming and to give a short introduction to the Multi-agent transport simulation (MATSim) which will be used in the lecture (Agent Based Modeling in Transportation) following this one. The programming language used in the course is Java. This course, therefore, has the main goal of providing the students without previous programming training the skills necessary for the successful completion of the Agent Based Modeling in Transportation course.

Content
The main Java concepts explained in the course are:
1) Types, Variables, Operators
2) Methods, Conditionals, Loops, Arrays
3) Objects and Classes
4) Access control, Class scope, Packages, Java API
5) Design, Debugging, Interfaces
6) Inheritance, Exceptions, File I/O

MATSim will be introduced on a basic level and its basic functionalities will be explained.
Weekly exercises will be focused on building Java knowledge through various examples using the MATSim environment.

Prerequisites / notice
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0449-00L</td>
<td><strong>Major in Transport Systems</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Management, Marketing, Quality</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>U. A. Weidmann</td>
</tr>
<tr>
<td></td>
<td>Transport and administrative policy, international and national regulation, business management of public transport companies, marketing, advertising and pricing; quality management</td>
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</tr>
<tr>
<td>Abstract</td>
<td>Comprehension of the transport and administrative policy as well as of the regulation of public transport companies. To develop a full understanding of the three important public transport system operations management processes: (1) Business management; (2) Marketing; (3) Quality control. The course will teach essential working techniques in each of these processes.</td>
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</tr>
<tr>
<td>Content</td>
<td>(1) Transport and administrative policy: Goals of the state related to public transports, governmental activities in public transport, regulation. (2) Business management in public transport enterprises: goals of public transport companies, goals of the business management; management of public transport on the different management levels, business organization. (3) Marketing, advertising and pricing: Fundamentals and goals; marketing strategies and concepts in public transports; marketing tools; putting marketing into action. (4) Quality control: Quality in transport systems; goals of quality management; structuring quality control measures; collecting quality data in an operating service; use of quality control systems for service optimization.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Course notes will be provided in German. Slides will be made available.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>References to technical literature will be included in the course script. An additional list of literature will be given during the course.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Lectures System and Network Planning as well as Systems Dimensioning and Capacity recommended.</td>
<td></td>
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</tr>
<tr>
<td>101-0479-00L</td>
<td>Safety and Reliability of Railway Systems</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>U. A. Weidmann, A. Bombhauer-Beins, O. Fink, M. Montigel</td>
</tr>
<tr>
<td>Abstract</td>
<td>Railway safety policies and safety concepts, command and control technologies for railways, optimization systems, European Train Control System, reliability availability maintainability safety (RAMS) of railway systems.</td>
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<tr>
<td>Objective</td>
<td>The students comprehend the main principles of safety, reliability and optimization for railway systems and understand the basic concepts of command and control technologies for railways.</td>
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</tr>
<tr>
<td>Content</td>
<td>Railway safety strategies o Safety in public transport o Safety relevant characteristic of railway transport o Safety requirements for railway transport o Safety concepts</td>
<td></td>
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<tr>
<td></td>
<td>Command and control technologies for railway systems o protective functions o ensure the sequence/spacing of trains o ensure route protection o ensure level crossing protection o technical realization for protective functions o European Train Control System</td>
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<tr>
<td></td>
<td>operational command/control systems o dispatching o operational control systems o concepts of optimization</td>
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<tr>
<td></td>
<td>RAMS for railway systems o accident investigation methods o RAMS standards for railways o risk analysis and hazard control o RAMS methods o design principles for availability and safety o maintenance strategies o Life Cycle Costs (LCC) o Human Factor o safety in long railway tunnels</td>
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<tr>
<td></td>
<td>tutorials in Railway Operation Laboratory field trip to Siemens Wallisellen (command and control technologies)</td>
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<tr>
<td>Lecture notes</td>
<td>The slides will be provided in German.</td>
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</tr>
<tr>
<td>Literature</td>
<td>References will be included in the lecture notes. An additional list of literature will be given during the course.</td>
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</tbody>
</table>
Road Safety

T. Netland

4G

ECTS


Simulation of Traffic Operations

T. Netland, P. Schönsleben

1 credit

2A

The course introduces basic strategies in microscopic traffic simulation, including model development, calibration, validation, data analysis, identification of strategies for improving traffic performance, and evaluation of such strategies. The simulation software used is VISSIM.

Objective

The objective of this course is to introduce basic concepts in microscopic traffic simulation and conduct a realistic traffic engineering project from beginning to end. Students will be familiarize themselves with microscopic traffic simulation models. They will then use the simulation model for modeling and analyzing the traffic operations. The emphasis is not only on building the simulation model, but also understanding the models behind and logically evaluating results. The final goal is to make valid and concrete engineering proposals based on the simulation model.

Content

In this course, students will first learn some microscopic traffic simulation concepts and then complete a traffic engineering project with microscopic traffic simulator VISSIM.

Microscopic simulation concepts will include:
1) Car following models
2) Lane change models

Specific tasks for the project include:
1) Building a model with the simulator VISSIM in order to replicate and analyze the traffic conditions measured/observed.
2) Calibrating and validating the simulation model.
3) Redesigning/extending the model to improve the traffic performance.

Lecture notes

The lecture notes and additional handouts will be provided before the lectures.

Literature

Additional literature recommendations will be provided at the lectures.

Prerequisites / notice

This course is recommended for students with some basic road transport concepts. The course Road Transport Systems (Verkehr III) or simultaneously taking the course Traffic Engineering is encouraged. The course Transport Simulation (101-0438-00 G) and previous experience with VISSIM is helpful but not mandatory.

 Infrastructure Management

Infrastructure Management 1: Process

B. T. Adey

3 credits

2G

The course provides an introduction to the steps included in the infrastructure management process. The lectures are given by a mixture of external people in German and internal people in English.
Objective
Upon completion of the course, students will
- understand the steps required to manage infrastructure effectively,
- understand the complexity of these steps, and
- have an overview of the tools that they can use in each of the steps.

Content
- The infrastructure management process and guidelines
- Knowing the infrastructure - Dealing with data
- Establishing goals and constraints
- Establishing organization structure and processes
- Making predictions
- Selecting strategies
- Developing programs
- Planning interventions
- Conducting impact analysis
- Reviewing the process

Lecture notes
Appropriate reading / and study material will be handed out during the course.
Transparencies will be handed out at the beginning of each class.

Literature
Appropriate literature will be handed out when required.

Prerequisites / notice
The courses will be given half in English and half in German. Students should have a minimum of level B2 in both to register for the course.

ujęg 13 Major Courses for all Majors

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0377-00L</td>
<td>Introduction to the Data Analysis Software R</td>
<td>W</td>
<td>1</td>
<td>1G</td>
<td>A. Grêt-Regamey, M. J. Van Strien</td>
</tr>
</tbody>
</table>

Abstract
R is one of the most popular statistical open-source software for data analysis and data modeling. It has proved very useful for a variety of tasks commonly faced by planners, such as data preparation, exploratory analysis, model estimation or graphical display. R is also a programming language providing users with a more flexible and powerful tool for solving more complex problems.

Objective
The aim of this course is to provide participants with an introduction to the statistical open-source software R. Students will learn how to read data from files and write data to files, and how these data can be used to plot graphs and maps. Since R is a command-line software, that is, one has to type in text commands at a prompt, rather than just clicking menus and buttons, students will also learn how to write their own functions.

Content
- Reading data from files
- Creating and handling R objects such as matrices, vectors and arrays
- Plotting data: histograms, boxplots, scattered plots
- Writing data to files
- Reading raster and vector data
- Writing for- and while-loops
- Writing your own functions

Lecture notes
Handouts of the lectures and exercises will be distributed

Literature
- "Introduction to R" by W. N. Venables and D. M. Smith
  available online at http://cran.r-project.org/doc/manuals/R-intro.pdf

Prerequisites / notice
The course will be held in English and no prior knowledge on R is required.

364-0517-00L | Urban and Spatial Economics | W    | 3     | 2V    | R. H. van Nieuwkoop |

Abstract
This course explores the economic factors which influence location decisions of households and firms, and it explores theories of how these decisions induce the formation of cities. The course will cover the neoclassical models of land use, concepts from the new economic geography, zoning, and transportation and traffic congestion.

Objective
The objective of the course is to provide graduate students with an understanding of the economic factors which give rise to urban spatial structure and the models which have been employed to study these processes. The course aims to help students develop an appreciation for the use of economic models in both positive and normative frameworks. We will assess both the history of thought regarding the role of markets in creating urban development, and we will read about modern theories of externalities and economic factors which induce agglomeration. The final section of the course will focus on transportation problems in urban areas and the use of economic models to assess public policy measures to deal with congestion and associated externalities.

Content
- Outline of Lectures
  - Topic 1: Why do cities exist?
  - Topic 2: The Basic Muth-Mills model
  - Topic 3: The New Economic Geography
  - Topic 4: Business demand for land and Von Thünen's model)
  - Topic 5: Urban spatial structure
  - Topic 6: Land use control
  - Topic 7: City size and city growth
  - Topic 8: Traffic externalities and congestion
  - Topic 9: Public transport

Lecture notes
- Textbook
  - Ancillary Texts
  - The new introduction to geographical economics, Steven Brakman, Harry Garretsen and Charles van Marrewijk, Cambridge.
Interdisciplinary Project Work

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0489-02L</td>
<td>Interdisciplinary Project  ■</td>
<td>O</td>
<td>12</td>
<td>24A</td>
<td>B. T. Adey, M. Menendez</td>
</tr>
</tbody>
</table>

**Abstract**
Working on a concrete interdisciplinary task on spatial development and infrastructure systems

**Objective**
Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

**Content**
The project work is supervised by a professor. Students can choose from different subjects and tasks.

Electives

The entire course programs of ETH Zurich and University Zurich are open to the students to individual selection. The students have themselves to check whether they meet the admission requirements for a course.

Recommended Electives of Bachelor Degree Programme

Students having enrolled for 851-0703-03 earlier (i.e. bachelor's degree programme or as additional requirement for master's degree programme) cannot enrol for this again during master's degree programme.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0249-00L</td>
<td>Selected Topics on Hydraulic Engineering</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>R. Boes, I. Albayrak</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture focuses on selected topics in hydraulic engineering, water management and aquatic ecology relating to hydropower and flood protection projects.

**Objective**
To deepen knowledge on special aspects in hydraulic engineering and to understand the procedures and the planning sequence of hydropower projects.

**Content**
Different selected topics in hydraulic engineering will be focused on, e.g. dam safety, possible problems at reservoirs like sedimentation or natural hazards by impulse waves, the hydraulics of river flows, spillways and intake structures at dams and weirs, hydropower and ecology like fish-ecological aspects at low-head hydropower plants and eco-hydraulics like flow-vegetation interaction. Another focus will be put on typical approaches and procedures in the planning process of hydropower projects.

**Lecture notes**
Lecture notes/handouts will be available online.

**Literature**
- Prerequisite: Cartography Introduction
- Further information at http://www.karto.ethz.ch/studium/lehrangebot.html

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<tr>
<th>Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>103-0245-01L</td>
<td>Thematic Cartography</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>L. Hurni</td>
</tr>
</tbody>
</table>

**Abstract**
Thematic map types (focus on quantitative information), analysis of themes and application, base maps, generalisation

**Objective**
Knowing of most important thematic map types.

**Content**
Dynamic thematic maps

**Lecture notes**
Will be distributed.

**Literature**
- Terry A. Slocum, Terry et al. (2004): Thematic Cartography and Geographic Visualization. 2nd ed. Prentice Hall, ISBN 0130351237

**Prerequisites / notice**
Further information at http://www.karto.ethz.ch/studium/lehrangebot.html

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<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0227-00L</td>
<td>Cartography III</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>L. Hurni</td>
</tr>
</tbody>
</table>

**Abstract**
Basic methods, technologies, scripting, and systems for interactive web mapping projects and in the internet cartography.

**Objective**
Gain knowledge about basic methods, technologies, scripting, and systems for interactive web mapping projects. Assessment of existing products regarding production methods. Definition of useful methods for Web-based map projects.

**Content**
- Web mapping
- Web Map Services (WMS)

**Lecture notes**
Own script and instructions will be distributed.

**Literature**

**Prerequisites / notice**
Further information at http://www.karto.ethz.ch/studium/lehrangebot.html

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0625-01L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W</td>
<td>5</td>
<td>2V+1U</td>
<td>L. Meier</td>
</tr>
</tbody>
</table>

**Abstract**

**Objective**
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

**Content**

**Literature**
<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>751-1551-00L</strong></td>
<td>Ressourcen- und Umweltökonomie</td>
</tr>
<tr>
<td>Abstract</td>
<td>Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.</td>
</tr>
<tr>
<td>Objective</td>
<td>Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.</td>
</tr>
<tr>
<td>Topics:</td>
<td>Introduction to resource and environmental economics, Importance of resource and environmental economics, Main issues of resource and environmental economics, Normative basis, Utilitarianism, Fairness according to Rawls, Economic growth and environment, Externalities in the environmental sphere, Governmental internalisation of externalities, Private internalisation of externalities: the Coase theorem, Free rider problem and public goods, Types of public policy, Efficient level of pollution, Tax vs. permits, Command and Control Instruments, Empirical data on non-renewable natural resources, Optimal price development: the Hotelling-rule, Effects of exploration and Backstop-technology, Effects of different types of markets, Biological growth function, Optimal depletion of renewable resources, Social inefficiency as result of over-use of open-access resources, Cost-benefit analysis and the environment, Measuring environmental benefit, Measuring costs, Concept of sustainability, Technological feasibility, Conflicts sustainability / optimality, Indicators of sustainability, Problem of climate change, Cost and benefit of climate change, Climate change as international ecological externality, International climate policy: Kyoto protocol, Implementation of the Kyoto protocol in Switzerland, Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>The script and lecture material are provided at: <a href="https://moodle-app2.let.ethz.ch/course/view.php?id=140">https://moodle-app2.let.ethz.ch/course/view.php?id=140</a></td>
</tr>
</tbody>
</table>

| **363-0541-00L**       | Systems Dynamics and Complexity                                                                                           |
| Objective              | A successful participant of the course is able to: - understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches - apply the problem solving cycle as a systematic approach to identify problems and their solutions - calculate project schedules according to the critical path method - setup and run systems dynamics models by means of the Vensim software - identify feedback cycles and reasons for unintended systems behavior - analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics. |
Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM. The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines.

Self-study tasks (discussion exercises, Vensim exercises), are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

The course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.

This course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.

**Objective**

At the end of the course students should:

- Know:
  - Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:

- Functional application in case studies and other problem oriented projects

Be able to reflect on:

- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:

- Transdisciplinary Case Study 2017

**Content**

The lecture is structured as follows:

- Overview of concepts and methods of inter-/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

**Lecture notes**

Handouts are provided by the lecturers

**Literature**

Selected scientific articles and book-chapters

**Prerequisites / notice**

This course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.
An environmental management system has the objective to continuously improve the environmental performance of the activities, products, services of a company. The company has to introduce different management procedures. The goal of this lecture is to provide basics and specific procedure to implement the environmental dimension in the planning and decision making processes of an organisation.

Environmental Management

Overview on environmental management and environmental management systems, general methods and principles.

Introduction to environmental mangement / environmental management systems, energy and material flows; economical and ecological problems in industry; characterisation of an enterprise (incl. management handbook); structur and contents of an environmental management system; overview on the ISO 14001 ff. series; methods for environmental evaluation and assessment; integrated management systems; planning methodology and life-cycle-design; planning exampl

Information about environmental management and environmental management systems will be provided by a CD or mail.

Details:
- Data: 06.11.2018 12:57
- Autumn Semester 2016
- Page 1297 of 1571
This course deepens students' knowledge of the environmental assessment methodologies and their various applications. This course has the aim of deepening students' knowledge of the environmental assessment methodologies and their various applications. In particular, students completing the course should have the

- Ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors.  
- Knowledge about the current state of the scientific discussion and new research developments.  
- Ability to properly plan, conduct and interpret environmental assessment studies.  
- Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers.  
- Inventory developments, transparency, data quality, data completeness, and data exchange formats.  
- Allocation (multioutput processes and recycling)  
- Hybrid LCA methods.  
- Consequential and marginal analysis.  
- Recent development in impact assessment.  
- Spatial differentiation in Life Cycle Assessment.  
- Workplace and indoor exposure in Risk and Life Cycle Assessment.  
- Uncertainty analysis.  
- Subjectivity in environmental assessments.  
- Multicriteria analysis.  
- Case Studies.

Lecture notes
No script. Lecture slides and literature will be made available on the lecture homepage.

Literature
Literature will be made available on the lecture homepage.

Prerequisites / notice
Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done classwork in this topic before are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. 2016: Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).

Evaluations ETH Zurich

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-BAUG.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability.

see GESS Science in Perspective: Language Courses ETH/UZH.

Master’s Thesis

Abstract
The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

Objective
To work independently and to produce a scientifically structured work.

Content
The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

Systems Engineering
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
This course is designed to familiarize students with formal methods to be used in general situations to solve problems. The content can be applied in the fields of Civil Engineering, Environmental Engineering, Geomatic Engineering and Spatial Planning and Infrastructure Systems.
Upon successful completion of the course the students will be able:
- to apply the basic solving problem process,
- to develop basic mathematical models to determine optimal solutions to problems, to
- develop basic models to be used in decision making, and
- to be able to conduct basic economic and cost-benefit analyses.

All of which will improve their ability to find optimal solutions to problems in the fields of Civil Engineering, Environmental Engineering, Geomatic Engineering and Spatial Planning and Infrastructure Systems.

The course introduces the basic theories and methods of transport planning.

To introduce the methods and tools of project management. To impart knowledge in the areas of project organisation and structure, project planning, resource management, project controlling and on team leadership and team work.

The relevant literature for self-studies will be announced. Course notes and slides will be provided in German in addition to this.


101-0414-AAL Transport Planning (Transportation I) E- 3 credits 2R K. W. Axhausen
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

The lecture course discusses the basic concepts, approaches and methods of transport planning in both their theoretical and practical contexts.

The course introduces the basic theories and methods of transport planning.

The relevant literature for self-studies will be announced. Course notes and slides will be provided in German in addition to this.


101-0415-AAL Railway Infrastructures (Transportation II) E- 3 credits 4R U. A. Weidmann
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

The lecture course discusses the basic concepts, approaches and methods of transport planning in both their theoretical and practical contexts.

The course introduces the basic theories and methods of transport planning.

The relevant literature for self-studies will be announced. Course notes and slides will be provided in German in addition to this.


101-0515-AAL Project Management E- 2 credits 4R B. T. Adey
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

General introduction to the development, the life cycle and the characteristics of projects. Introduction to, and experience with, the methods and tools to help with the preparation, evaluation, organisation, planning, controlling and completion of projects.

Yes

The transparencies will be available for download from the website at least one week before each class. Copies of all necessary documents will be distributed at appropriate times.
Abstract
Focus of the course are the method, the process and content of the Environmental Impact Assessment (EIA) as well as the legal bases and methods for compiling an environmental impact study (EIS). Excursions provide a comprehensive view of the EIA.

Objective
- Understanding the context of spatial planning and environmental protection
- Ability to use central planning instruments and procedures for assessing the environmental impacts and risks of projects
- Ability to apply quantitative methods to assess the environmental impacts and risks of projects
- Knowledge about the process and content of an EIA
- a capacity for critical review of environmental impact assessments

Content
- Nominal and functional environmental protection in Switzerland
- Instruments of environmental protection
- Need for coordination between environmental protection and spatial planning
- Environmental Protection and environmental impact assessment
- Legal basis of the EIA
- Procedure of EIA
- Content of the EIA
- Application of the impact analysis
- Monitoring and Controlling
- View regarding the strategic environmental assessment (SEA)
- Excursions to projects obligated under the EIA

Lecture notes
No script. The documents for the lecture can be found for download on the homepage of the Chair of Planning of Landscape and Urban Systems.

Literature
Supplementary literature is available for download on the homepage of the Chair of Planning of Landscape and Urban Systems.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0233-AAL</td>
<td>GIS I</td>
<td>3</td>
<td>2R</td>
<td>M. Raubal</td>
</tr>
<tr>
<td>103-0234-AAL</td>
<td>GIS II</td>
<td>5</td>
<td>4R</td>
<td>M. Raubal</td>
</tr>
<tr>
<td>103-0313-AAL</td>
<td>Planning I</td>
<td>5</td>
<td>4R</td>
<td>G. Nussbaumer</td>
</tr>
<tr>
<td>103-0435-AAL</td>
<td>Landmanagement</td>
<td>5</td>
<td>4R</td>
<td>G. Nussbaumer</td>
</tr>
<tr>
<td>252-0835-AAL</td>
<td>Computer Science</td>
<td>4</td>
<td>9R</td>
<td>F. O. Friedrich</td>
</tr>
</tbody>
</table>

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Fundamentals in geoinformation technologies: database principles, including modeling of spatial information, geometric and semantic models, topology and metrics; practical training with GIS software.

Objective
Know the fundamentals in geoinformation technologies for the realization, application and operation of geographic information systems in engineering projects.

Content
Modelling of spatial information
Geometric and semantic models
Topology & metrics
Raster and vector models
Databases
Applications
Labs with GIS software

Literature

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Advanced course in geoinformation technologies: conceptual and logical modelling of networks, 3D- and 4D-data and spatial processes in GIS; raster data structures and operations; mobile GIS; Internet and GIS; interoperability and data transfer; legal and technical foundations of spatial data infrastructures (SDI).

Objective
Students will be able to carry out the following phases of a GIS project: data modelling, mobile data acquisition and analysis, Web publication of data and integration of interoperable geospatial web services into a Spatial Data Infrastructure (SDI).

Students will deepen their knowledge of conceptual and logical modeling by means of the particular requirements of networks as well as 3D- and 4D-data.

Literature

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Abstract
The lecture introduce into the main-features of spatial planning. Attended will be the themes planning as a national responsibility, instruments of spatial planning, techniques for problem-solutions in spatial planning and the swiss concept for regional planning.

Objective
- To get to know the interaction between the community and our living space and their resulting conflicts.
- Link theory and practice in spatial planning.
- To get to know instruments and facilities to process problems in spatial planning.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Spatial planning on the Commune level with focus on the special land use management. Land re-allocation as an instrument of spatial planning; specific explanations for land re-allocations in rural regions and in construction zones. Land marketing: the view of investors.

Objective
Getting knowledge in spatial planning and land re-allocation as an interactive process.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Excursions provide a comprehensive view of the EIA.

Objective
Using exemplary projects, the process of an EIA will be worked out by the students.

Content
- Nominal and functional environmental protection in Switzerland
- Instruments of environmental protection
- Need for coordination between environmental protection and spatial planning
- Environmental Protection and environmental impact assessment
- Legal basis of the EIA
- Procedure of EIA
- Content of the EIA
- Application of the impact analysis
- Monitoring and Controlling
- View regarding the strategic environmental assessment (SEA)
- Excursions to projects obligated under the EIA

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Literature
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Abstract
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The lecture introduce into the main-features of spatial planning. Attended will be the themes planning as a national responsibility, instruments of spatial planning, techniques for problem-solutions in spatial planning and the swiss concept for regional planning.

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- To get to know the interaction between the community and our living space and their resulting conflicts.
- Link theory and practice in spatial planning.
- To get to know instruments and facilities to process problems in spatial planning.

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Abstract
Spatial planning on the Commune level with focus on the special land use management. Land re-allocation as an instrument of spatial planning; specific explanations for land re-allocations in rural regions and in construction zones. Land marketing: the view of investors.

Objective
Getting knowledge in spatial planning and land re-allocation as an interactive process.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.
Abstract
The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Taught language is C++. No programming experience is required.

Objective
Primary educational objective is to learn programming with C++. When successfully attended the course, students have a good command of the mechanisms to construct a program. They know the fundamental control and data structures and understand how an algorithmic problem is mapped to a computer program. They have an idea of what happens "behind the scenes" when a program is translated and executed.

Secondary goals are an algorithmic computational thinking, understanding the possibilities and limits of programming and to impart the way of thinking of a computer scientist.

Content
The course covers fundamental data types, expressions and statements, (Limits of) computer arithmetic, control statements, functions, arrays, structural types and pointers. The part on object orientation deals with classes, inheritance and polymorphism, simple dynamic data types are introduced as examples.

In general, the concepts provided in the course are motivated and illustrated with algorithms and applications.

Literature
Andrew Koenig and Barbara E. Moo: Accelerated C++, Addison-Wesley, 2000
Bjarne Stroustrup: The Design and Evolution of C++, Addison-Wesley, 1994

252-0846-AAL Computer Science II E- 4 credits 9R F. O. Friedrich
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Objective
The course offers an introduction to variables, control structures (branch, loop), algorithms and data structures, as well as an outlook to object orientation and derived objects.

Content
A. Cannas da Silva

Literature
- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).
- Andrew Koenig and Barbara E. Moo: Accelerated C++, Addison-Wesley, 2000

206-0242-AAL Analysis II E- 7 credits 15R M. Akveld, C. Busch
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Objective
Mathematical tools of an engineer

Content

Literature
Textbooks in English:
- J. Stewart: Multivariable Calculus, Thomson Brooks/Cole
- V. I. Smirnov: A course of higher mathematics, Vol. II. Advanced calculus
- M. Akveld, R. Sperb, Analysis II, vdf
- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag

206-0251-AAL Mathematics I E- 6 credits 13R A. Cannas da Silva
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.

Objective
Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

Content
1. Linear Algebra and Complex Numbers:
systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.

2. Single-Variable Calculus:
review of differentiation, linearsiation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.

3. Ordinary Differential Equations:
review of differentiation, linearsiation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.

Literature
- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).

Prerequisites / notice
Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.

Assistance:
Tuesdays and Wednesdays 17-19h, in Room HG E 41.
Abstract
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content
From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student's t Distribution
Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

Literature
- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435

From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m1757b/

Abstract
This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.

Objective
Introduction to fundamental questions of public and private law which serves as a foundation for more advanced law classes.

Content
1. Public Law
Constitutional law: sources of law, organization of the state, fundamental rights. Administrative law: administrative decisions, organization of the administration, enforcement of administrative decisions, procedural law, basics of police, environmental and zoning law.

2. Private law

Lecture notes
The posted basic Skript will be in German. Course slides will be in English and German (but for the reproduction of cases, which will be posted in the original language). Additional introduction to law material/ information will also be posted.

Literature
Further information is available at http://www.hertig.ethz.ch/education/grundzuege-des-rechts-fuer-baug-und-arch.html

Abstract
Introduction to business administration
Principles of accounting and financial management
Financial planning and capital budgeting of projects
Costing systems by corporations

Objective
Prepare and analyze the financial statements of organizations
Understand the major costing systems
Establish budget and determine profitability of investment
Perform some product calculations

Literature
Further information is available at http://www.hertig.ethz.ch/education/grundzuege-des-rechts-fuer-baug-und-arch.html
Content
Overview in business administration

- Financial Accounting
  - Balance sheet, income statement
  - Accounts, double-entry bookkeeping
  - Year-end closing and financial statements

- Financial Management
  - Financial statement analysis
  - Financial planning
  - Investment decisions

- Management Accounting
  - Full costing and marginal costing
  - Product costing
  - Management decisions

Literature
The script for the original course 101-0031-02 Betriebswirtschaftslehre is in German. The English material that can be used for the virtual course will be given out on an as need basis.

<table>
<thead>
<tr>
<th>Code</th>
<th>Course</th>
<th>Credits</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td>651-3070-AAL</td>
<td>Fundamentals of Geology</td>
<td>E- 6</td>
<td></td>
</tr>
</tbody>
</table>
  *Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.*
  
  Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Spatial Development and Infrastructure Systems Master - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Computational Science and Engineering Bachelor

Bachelor Studies (Programme Regulations 2016)

First Year Compulsory Courses

First Year Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0151-00L</td>
<td>Linear Algebra</td>
<td>O</td>
<td>4</td>
<td>3G+2U</td>
<td>V. C. Gradinaru, R. Käppeli</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Einführung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, 5. Auflage 2002</td>
</tr>
<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
<td></td>
<td>K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, 5. Auflage 2002</td>
</tr>
<tr>
<td>252-0025-00L</td>
<td>Discrete Mathematics</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>U. Maurer</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Content: Mathematical reasoning and proofs, abstraction. Sets, relations (e.g. equivalence and order relations), functions, (un-)countability, number theory, algebra (groups, rings, fields, polynomials, subalgebras, morphisms), logic (propositional and predicate logic, proof calculus)</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>The primary goals of this course are (1) to introduce the most important concepts of discrete mathematics, (2) to understand and appreciate the role of abstraction and mathematical proofs, and (3) to discuss a number of applications, e.g. in cryptography, coding theory, and algorithm theory.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>See course description.</td>
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<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
<td></td>
<td>available (in english)</td>
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<tr>
<td>227-0003-00L</td>
<td>Digital Circuits</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>G. Tröster</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Digital and analogue signals and their representation, Combinational and sequential circuits and systems, boolean algebra, K-maps. Finite state machines, Memory and computing building blocks in CMOS technology, programmable logic circuits.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Provide basic knowledge and methods to understand and to design digital circuits and systems.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Digital and analogue signals and their representation. Boolean Algebra, circuit analysis and synthesis, the MOS transistor, CMOS logic, static and dynamic behaviour, tristate logic, Karnough-Maps, hazards, binary number systems, coding, Combinational and sequential circuits and systems (boolean algebra, K-maps, etc.), Memory building blocks and memory structures, programmable logic circuits. Finite state machines, architecture of microprocessors.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>Lecture notes for all lessons, assignments and solutions.</td>
</tr>
<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
<td></td>
<td>Textbook: <a href="http://www.ifc.ee.ethz.ch/education/Digitaltechnik">http://www.ifc.ee.ethz.ch/education/Digitaltechnik</a></td>
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</table>

Computer science includes

No special prerequisites

First Year Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0231-10L</td>
<td>Analysis I</td>
<td>O</td>
<td>8</td>
<td>4V+3U</td>
<td>D. A. Salamon</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Calculus of one variable: Real and complex numbers, vectors, limits, sequences, series, power series, continuous maps, differentiation and integration in one variable, introduction to ordinary differential equations</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Einführung in die Grundlagen der Analysis</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>Konrad Koenigsberger, Analysis I, Christian Blatter: Ingenieur-Analyse (Kapitel 1-3)</td>
</tr>
</tbody>
</table>

Bachelor Studies (Programme Regulations 2012)

First Year

Course Units of the first year can be found in section Bachelor Studies (Programme Regulations 2016) - First Year Compulsory Courses.

Basic Courses

Block G1

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0353-00L</td>
<td>Analysis III</td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>
In this lecture we treat problems in applied analysis. The focus lies on the simplest cases of three fundamental types of partial differential equations of second order: the Laplace equation, the heat equation and the wave equation.

Abstract

Content

1.) Klassifizierung von PDE’s
- linear, quasilinear, nicht-linear
- elliptisch, parabolisch, hyperbolisch

2.) Quasilineare PDE
- Methode der Charakteristiken (Beispiele)

3.) Elliptische PDE
- Bsp: Laplace-Gleichung
- Harmonische Funktionen, Maximumsprinzip, Mittelwerts-Formel.
- Methode der Variablenseparation

4.) Parabolische PDE
- Bsp: Wärmeleitungsgleichung
- Bsp: Inverse Wärmeleitungsgleichung
- Methode der Variablenseparation

5.) Hyperbolische PDE
- Bsp: Wellengleichung
- Formel von d’Alembert in (1+1)-Dimensionen
- Methode der Variablenseparation

6.) Green’sche Funktionen
- Rechnen mit der Dirac-Deltafunktion
- Idee der Green’schen Funktionen (Beispiele)

7.) Ausblick auf numerische Methoden
- 5-Punkt-Diskretisierung des Laplace-Operators (Beispiele)

Literature


Zusätzliche Literatur:
- Norbert Hungerbühler, "Einführung in die partiellen Differentialgleichungen", vdf Hochschulverlag AG an der ETH Zürich.
- G. Felder: Partielle Differentialgleichungen.
- https://people.math.ethz.ch/~felder/PDG/

Prerequisites / notice

402-0811-00L Programming Techniques for Scientific Simulations I

Abstract

This lecture provides an overview of programming techniques for scientific simulations. The focus is on advances C++ programming techniques and scientific software libraries. Based on an overview over the hardware components of PCs and supercomputer, optimization methods for scientific simulation codes are explained.

Objective

* Knowledge of the fundamental algorithms in numerical mathematics
* Knowledge of the essential terms in numerical mathematics and the techniques used for the analysis of numerical algorithms
* Ability to choose the appropriate numerical method for concrete problems
* Ability to interpret numerical results
* Ability to implement numerical algorithms efficiently

Content

1. Direct Methods for linear systems of equations
2. Least Squares Techniques
3. Data Interpolation and Fitting
4. Filtering Algorithms
5. Approximation of Functions
6. Numerical Quadrature
7. Iterative Methods for non-linear systems of equations
8. Single Step Methods for ODEs
9. Stiff Integrators

Lecture notes

Lecture materials (PDF documents and codes) will be made available to participants:


Lecture Git repository: https://gitlab.math.ethz.ch/NumCSE/NumCSE

Tablet classroom notes: http://www.sam.math.ethz.ch/~grsam/HS16/NumCSE/NCSE16_Notes/

Lecture recording: http://www.video.ethz.ch/lectures/d-math/2016/autumn/401-0663-00L.html

Homework problems: https://people.math.ethz.ch/~grsam/HS16/NumCSE/NCSEProblems.pdf

Literature


M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002

P. Deuflhard and A. Hohmann, "Numerische Mathematik I", DeGruyter, 2002

Prerequisites / notice

The course will be accompanied by programming exercises in C++ relying on the template library EIGEN. Familiarity with C++, object oriented and generic programming is an advantage. Participants of the course are expected to learn C++ by themselves.
Block G2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0603-00L</td>
<td>Stochastics (Probability and Statistics)</td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>M. H. Maathuis</td>
</tr>
</tbody>
</table>

Abstract
This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for normally distributed data, point estimation, and two-sample tests.

Objective
Knowledge of the basic principles of probability and statistics.

Content
Introduction to probability theory, some basic principles from mathematical statistics and basic methods for applied statistics.

Lecture notes
Lecture notes

Literature

252-0834-00L | Information Systems for Engineers               | O    | 4    | 2V+1U   | R. Marti           |

Abstract
Foundations of information systems from a user's viewpoint. The focus is on structured data: relational databases, the data language SQL, designing relational databases. Additional topics: Information Retrieval (searching documents), and estimating their relevance and authority with respect to free-text queries; XML as a format for data exchange; Characteristics and processing of "Big Data".

Objective
Following the course should enable students to

1. answer non-trivial queries on existing relational databases by formulating (entry-level) SQL statements, as well as to add new database content and to update or delete existing content,

2. formalize facts as perceived in the real world in terms of the entity-relationship model, and derive a set of normalized relations (tables) which define the structure of a relational database

3. explain how a database management system (DBMS) essentially works and what kind of services it provides

4. understand how a web search engine such as Google basically works

5. know and apply the core concepts to structure and query XML-documents

6. list the characteristics of "Big Data" and know the basics of processing "Big Data"

Content
Die Lehrveranstaltung vermittelt Grundlagen und Konzepte von Informationssystemen aus der Sicht eines Anwenders.

Im Zentrum stehen relationale Datenbanksysteme, die Abfrage- und Datenmanipulationssprache SQL, sowie der Entwurf bzw. die Strukturierung relationaler Datenbanken. Dieser Stoff wird auch in praktischen Übungen vertieft.

Weitere Themen sind der Umgang mit unstrukturierten und semistrukturierten Daten, die Integration von Daten aus verschiedenen autonomen Informationssystemen, sowie eine Übersicht der Architektur von Datenbanksystemen.

Inhalt:
1. Einleitung.
2. Das Relationenmodell.
3. Die Abfrage- und Datenmanipulationssprache SQL.
5. Architektur relationaler Datenbanksysteme.

Literature
Vorlesungsunterlagen (PowerPoint Folien, teilweise auch zusätzlicher Text) werden auf der Web-Site publiziert. Der Kauf eines Buches wird nicht vorausgesetzt.


Als englischsprachiges Werk kann z.B.


Prerequisites / notice
empfohlen werden (Umfang: 1349 Seiten).

401-0647-00L | Introduction to Mathematical Optimization         | O    | 5    | 2V+1U   | D. Adjiashvili     |

Abstract
Introduction to basic techniques and problems in mathematical optimization, and their applications to problems in engineering.

Objective
The goal of the course is to obtain a good understanding of some of the most fundamental mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems. The students will also practice applying the learned models to problems in engineering.

Content
Topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).
- Modelling with mathematical optimization: applications of mathematical programming in engineering.

Literature
Information about relevant literature will be given in the lecture.

Prerequisites / notice
This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

Block G3

All course units within Block G3 are offered in the spring semester.
Block G4

Students that enrol for the second year in the CSE Bachelor Programme and whose first year examination did not involve the subject “Physics I” will instead take the “Physics I and II” (402-0043-00L and 402-0044-00L) courses with performance assessment as a yearly course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0043-00L</td>
<td>Physics I</td>
<td>W</td>
<td>4 credits</td>
<td>3V+1U</td>
<td>T. Esslinger</td>
</tr>
</tbody>
</table>

Abstract: Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

Objective: The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.

Content: Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids) Periodic Motion and Waves (periodic motion, mechanical waves, acoustics).

Lecture notes: The lecture follows the book “Physics” by Paul A. Tipler.

Literature: Paul A. Tipler and Gene P. Mosca, Physics (for Scientists and Engineers), W. H. Freeman and Company

Prerequisites: Mathematics I & II

Core Courses

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0107-20L</td>
<td>High Performance Computing for Science and Engineering (HPCSE) I</td>
<td>O</td>
<td>4 credits</td>
<td>4G</td>
<td>M. Troyer, P. Chatzidoukas</td>
</tr>
</tbody>
</table>

Abstract: This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective: Introduction to HPC for scientists and engineers

Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content: Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes: http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

Fields of Specialization

Astrophysics

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-7851-00L</td>
<td>Theoretical Astrophysics (University of Zurich)</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>R. Teysier</td>
</tr>
</tbody>
</table>

Abstract: Radiative processes in the interstellar medium; stellar structure and evolution; supernovae; white dwarfs; neutron stars; black holes; planet formation

Literature:
1. “Formation of stars” (S. Stahler and F. Palla - Wiley editions, this is the book on which about half of the classes will be based and photocopies will be organized during first lecture)
2. “Radiative processes in astrophysics” (R. Ribycki and A. Lightman)

Additionally PowerPoint slides will be prepared by the lecturer on these and extra topics (e.g. planet formation).

Prerequisites / notice: Prerequisites: Elementary atomic physics, thermodynamics, mechanics, fluid dynamics.

Introduction to astrophysics (preferred but not obligatory).

<table>
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<tbody>
<tr>
<td>401-7855-00L</td>
<td>Computational Astrophysics (University of Zurich)</td>
<td>W</td>
<td>6 credits</td>
<td>2V</td>
<td>L. M. Mayer</td>
</tr>
</tbody>
</table>

Abstract: Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programmes

Objective: Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programmes

Content: 1. Integration of ODE, Hamiltonians and Symplectic integration techniques, time adaptivity, time reversibility
2. Large-N gravity calculation, collisionless N-body systems and their simulation
3. Fast Fourier Transform and spectral methods in general
4. Eulerian Hydrodynamics: Upwinding, Riemann solvers, Limiters
5. Lagrangian Hydrodynamics: The SPH method
6. Resolution and instabilities in Hydrodynamics
7. Initial Conditions: Cosmological Simulations and Astrophysical Disks
8. Physical Approximations and Methods for Radiative Transfer in Astrophysics
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.  

Some knowledge of UNIX, scripting languages (see www.physik.uzh.ch/lectures/informatik/python/ as an example), some prior experience programming, knowledge of C, C++ beneficial.

### Physics of the Atmosphere

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<tbody>
<tr>
<td>701-0023-00L</td>
<td>Atmosphere</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>H. Wernli, E. M. Fischer, T. Peter</td>
</tr>
</tbody>
</table>

**Abstract**
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Objective**
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

**Content**
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Lecture notes**
Written information will be supplied.

**Literature**

### Chemistry

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0004-00L</td>
<td>Computer Simulation in Chemistry, Biology and</td>
<td>W</td>
<td>7 credits</td>
<td>4G</td>
<td>P. H. Hünlenberger</td>
</tr>
</tbody>
</table>

**Abstract**
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

**Objective**
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

**Content**
Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

**Lecture notes**
Available (copies of powerpoint slides distributed before each lecture)

**Literature**
See: www.csms.ethz.ch/education/CSCBP

### Fluid Dynamics

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<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0103-00L</td>
<td>Fluid Dynamics II</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>P. Jenny</td>
</tr>
</tbody>
</table>

**Abstract**

**Objective**
Expand basic knowledge of fluid dynamics.

**Content**

**Lecture notes**
Lecture notes are available (in German). (See also info on literature below.)

**Literature**
Relevant chapters (corresponding to lecture notes) from the textbook


### Systems and Control

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0103-00L</td>
<td>Control Systems</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U</td>
<td>F. Dörfler</td>
</tr>
</tbody>
</table>

**Abstract**
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

**Objective**
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.


No lecture notes, but slides will be made available on the course webpage.

## Literature

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>151-0601-00L</td>
<td>Theory of Robotics and Mechatronics</td>
</tr>
<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
</tr>
<tr>
<td>263-5902-00L</td>
<td>Computer Vision</td>
</tr>
</tbody>
</table>

### Prerequisites / notice

MATLAB is used for system analysis and simulation.
Introduction to Dynamic Programming and Optimal Control. Covers the fundamental concepts of Dynamic Programming & Optimal Control.

ECTS Type Hours 2V+2U

The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

Objectives of this course are:
1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve those.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

Content
Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

Prerequisites / notice
It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

151-0563-01L Dynamic Programming and Optimal Control

Abstract
Introduction to Dynamic Programming and Optimal Control.

Objective
Covers the fundamental concepts of Dynamic Programming & Optimal Control.

Content
Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

Literature

Prerequisites / notice
Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

151-0851-00L Robot Dynamics

Abstract
An overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

Objective
The primary objective of this course is that the student develops an understanding about how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

Content
The course consists of three parts: First, we will refresh and deepen the student’s knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadricopters and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

Prerequisites / notice
The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.

Physics

Number Title Type ECTS Hours Lecturers
402-0809-00L Introduction to Computational Physics W 8 credits 2V+2U H. J. Herrmann

Computational Finance

Number Title Type ECTS Hours Lecturers
401-3913-01L Mathematical Foundations for Finance W 4 credits 3V+2U E. W. Farkas, M. Schweizer

Abstract
First introduction to main modelling ideas and mathematical tools from mathematical finance.

Objective
This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

Content
Topics to be covered include
- financial market models in finite discrete time
- absence of arbitrage and martingale measures
- valuation and hedging in complete markets
- basics about Brownian motion
- stochastic integration
- stochastic calculus: Itô's formula, Girsanov transformation, Itô's representation theorem
- Black-Scholes formula

Lecture notes
Lecture notes will be sold at the beginning of the course.

Literature
Lecture notes will be sold at the beginning of the course. Additional (background) references are given there.

Prerequisites / notice
Prerequisites: Results and facts from probability theory as in the book "Probability Essentials" by J. Jacod and P. Protter will be used freely. Especially participants without a direct mathematics background are strongly advised to familiarise themselves with those tools before (or very quickly during) the course. (A possible alternative to the above English textbook are the (German) lecture notes for the standard course "Wahrscheinlichkeitstheorie".)

For those who are not sure about their background, we suggest to look at the exercises in Chapters 8, 9, 22-25, 28 of the Jacod/Protter book. If these pose problems, you will have a hard time during the course. So be prepared.

401-4657-00L Numerical Analysis of Stochastic Ordinary Differential Equations

Abstract
Alternative course title: "Computational Methods for
Quantitative Finance: Monte Carlo and Sampling
Methods

Abstract
Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

Objective
The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Content
- Generation of random numbers
- Monte Carlo methods for the numerical integration of random variables
- Stochastic processes and Brownian motion
- Stochastic ordinary differential equations (SODEs)
- Numerical approximations of SODEs
- Multilevel Monte Carlo methods for SODEs
- Applications to computational finance: Option valuation

Lecture notes
Lecture Notes are available in the lecture homepage (please follow the link in the Learning materials section).

Literature

Prerequisites / notice
Prerequisites:
- Mandatory: Probability and measure theory, basic numerical analysis and basics of MATLAB programming.
- a) mandatory courses:
  - Elementary Probability,
  - Probability Theory I.
- b) recommended courses:
  - Stochastic Processes.

Start of lectures: Wednesday, September 21, 2016
For more details, please follow the link in the Learning materials section.

Electromagnetics

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-2037-00L</td>
<td>Physical Modelling and Simulation</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>C. Hafner, J. Leuthold, J. Smajic</td>
</tr>
</tbody>
</table>

Abstract
This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

Objective
Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.

Content
The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, linear equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetic-thermal analysis of MEMS.

In the second part of the course the students will work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.

Geophysics

Recommended combinations:
- Subject 1 + Subject 2
- Subject 1 + Subject 3
- Subject 2 + Subject 3
- Subject 3 + Subject 4
- Subject 5 + Subject 6
- Subject 5 + Subject 4

Geophysics: Subject 1

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<tr>
<td>651-4007-00L</td>
<td>Continuum Mechanics</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>T. Gerya</td>
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</table>

Abstract
In this course, students learn crucial partial differential equations (conservation laws) that are applicable to any continuum including the Earth's mantle, core, atmosphere and ocean. The course will provide step-by-step introduction into the mathematical structure, physical meaning and analytical solutions of the equations. The course has a particular focus on solid Earth applications.

Objective
The goal of this course is to learn and understand few principal partial differential equations (conservation laws) that are applicable for analysing and modelling of any continuum including the Earth's mantle, core, atmosphere and ocean. By the end of the course, students should be able to write, explain and analyse the equations and apply them for simple analytical cases. Numerical solving of these equations will be discussed in the Numerical Modelling I and II course running in parallel.
A provisional week-by-week schedule (subject to change) is as follows:

Week 1: The continuity equation
Exercise: Computing the divergence of velocity field.

Week 2: Density and gravity

Week 3: Stress and strain

Week 4: The momentum equation

Week 5: Viscous rheology of rocks
Theory: Solid-state creep of minerals and rocks as the major mechanism of deformation of the Earth's interior. Dislocation and diffusion creep mechanisms. Rheological equations for minerals and rocks. Effective viscosity and its dependence on temperature, pressure and strain rate. Formulation of the effective viscosity from empirical flow laws. Exercise: Deriving viscous rheological equations for computing effective viscosities from empirical flow laws.

Week 6: The heat conservation equation

Week 7: Elasticity and plasticity

GRADING will be based on homeworks (30%) and oral exams (70%).
Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS

Lecture notes
Script is available by request to taras.gerya@erdw.ethz.ch
Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS

Literature
Taras Gerya Introduction to Numerical Geodynamic Modelling Cambridge University Press, 2010

Geophysics: Subject 2

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<tbody>
<tr>
<td>651-4241-00L</td>
<td>Numerical Modelling I and II: Theory and Applications</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>T. Gerya</td>
</tr>
</tbody>
</table>

In this 13-week sequence, students learn how to write programs from scratch to solve partial differential equations that are useful for Earth science applications. Programming will be done in MATLAB and will use the finite-difference method and marker-in-cell technique. The course will emphasise a hands-on learning approach rather than extensive theory.

The goal of this course is for students to learn how to program numerical applications from scratch. By the end of the course, students should be able to write state-of-the-art MATLAB codes that solve systems of partial-differential equations relevant to Earth and Planetary Science applications using finite-difference method and marker-in-cell technique. Applications include Poisson equation, buoyancy driven variable viscosity flow, heat diffusion and advection, and state-of-the-art thermomechanical code programming. The emphasis will be on commonality, i.e., using a similar approach to solve different applications, and modularity, i.e., re-use of code in different programs. The course will emphasise a hands-on learning approach rather than extensive theory, and will begin with an introduction to programming in MATLAB.

GRADING will be based on weekly programming homeworks (50%) and a term project (50%) to develop an application of their choice to a more advanced level.
Seismic Tomography

Spatio-Temporal Modelling in Biology

Lecturers

E. Kissling, T. Diehl

This course focuses on modeling spatio-temporal problems in biology, in particular on the cell and tissue level. A wide range of mathematical techniques will be presented as part of the course, including concepts from non-linear dynamics (ODE and PDE models), stochastic techniques (SDE, Master equations, Monte Carlo simulations), and thermodynamic descriptions.

Computational Systems Biology

Objective

The aim of the course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content

Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Lecture notes


Biography


All lecture material will be made available online

https://www.bsse.ethz.ch/cobi/education/636-0706-00L_Spatial_Modelling_in_Biology.html
### Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0113-00L</td>
<td>Applied Fluid Dynamics</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>J.P. Kunsch</td>
</tr>
<tr>
<td>Abstract</td>
<td>The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment. Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).</td>
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<tr>
<td>Objective</td>
<td>Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples. Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water. There are many possible forms that the resulting damage may take, including fire and explosion when flammable substances are mixed. The topics covered include: Emissions of liquids and gases from containers and pipelines, evaporation from pools and vaporization of gases kept under pressure, the spread and dilution of waste gas plumes in the wind, deflagration and detonation of inflammable gases, fireballs in gases held under pressure, pollution and exhaust gases in tunnels (tunnel fires etc.)</td>
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<tr>
<td>Content</td>
<td>Content not available</td>
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<tr>
<td>Lecture notes</td>
<td>Requirements: successful attendance at lectures &quot;Fluidodynamik I und II&quot;, &quot;Thermodynamik I und II&quot;</td>
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<tr>
<td>151-0709-00L</td>
<td>Stochastic Methods for Engineers and Natural Scientists</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>D. W. Meyer-Massetti, N. Noiray</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides an introduction into stochastic methods that are applicable for example for the description and modeling of turbulent and subsurface flows. Moreover, mathematical techniques are presented that are used to quantify uncertainty in various engineering applications.</td>
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<tr>
<td>Objective</td>
<td>By the end of the course you should be able to mathematically describe random quantities and their effect on physical systems. Moreover, you should be able to develop basic stochastic models of such systems.</td>
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<tr>
<td>Content</td>
<td>- Probability theory, single and multiple random variables, mappings of random variables - Stochastic differential equations, Itô calculus, PDF evolution equations - Polynomial chaos and other expansion methods - All topics are illustrated with application examples from engineering.</td>
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<tr>
<td>Lecture notes</td>
<td>Detailed lecture notes will be provided.</td>
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<tr>
<td>151-0317-00L</td>
<td>Visualization, Simulation and Interaction - Virtual Reality II</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Kunz</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture provides deeper knowledge on the possible applications of virtual reality, its basic technology, and future research fields. The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes. Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems. The goal of the lecture is to provide a deeper knowledge of today's VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.</td>
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<tr>
<td>Objective</td>
<td>Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems. The goal of the lecture is to provide a deeper knowledge of today's VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.</td>
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<tr>
<td>Content</td>
<td>Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of simulation; compression procedures of image-, audio-, and video signals; new materials for force feedback devices; introduction into data security; cryptography; definition of free-form surfaces; digital factory; new research fields of virtual reality</td>
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<tr>
<td>Lecture notes</td>
<td>The handout is available in German and English.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: &quot;Visualization, Simulation and Interaction - Virtual Reality II&quot; is recommended. Didactical concept: The course consists of lectures and exercises.</td>
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<tr>
<td>151-0833-00L</td>
<td>Principles of Nonlinear Finite-Element-Methods</td>
<td>W</td>
<td>5</td>
<td>2V+2U</td>
<td>N. Manopulo, B. Berisha, P.Hora</td>
</tr>
<tr>
<td>Abstract</td>
<td>Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems. The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of: - Crash - Collapse of structures - Materials in Biomechanics (soft materials) - General forming processes Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations.</td>
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Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1314 of 1571
### Content
- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

### Lecture notes
Yes

### Literature

### Prerequisites / notice
If we will have a large number of students, two dates for the exercises will be offered.

### 283-5001-00L Introduction to Finite Elements and Sparse Linear System Solving

**Abstract**
The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that a typical for the FE method. We will consider direct and iterative methods.

**Objective**
Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.

**Content**

1. **THE FINITE ELEMENT METHOD**
   - Introduction, model problems.
   - 1D problems. Piecewise polynomials in 1D.
   - 2D problems. Triangulations. Piecewise polynomials in 2D.
   - Implementation aspects.

2. **DIRECT SOLUTION METHODS**
   - LU and Cholesky decomposition.
   - Sparse matrices.
   - Fill-reducing orderings.

3. **ITERATIVE SOLUTION METHODS**
   - Stationary iterative methods, preconditioning.
   - Preconditioned conjugate gradient method (PCG).
   - Incomplete factorization preconditioning.
   - Multigrid preconditioning.
   - Nonsymmetric problems (GMRES, BiCGstab).
   - Indefinite problems (SYMMLQ, MINRES).

**Literature**

**Prerequisites / notice**
Prerequisites: Linear Algebra, Analysis, Computational Science. The exercises are made with Matlab.

### 283-3010-00L Big Data

**Abstract**
The key challenge of the information society is to turn data into information, information into knowledge, knowledge into value. This has become increasingly complex. Data comes in larger volumes, diverse shapes, from different sources. Data is more heterogeneous and less structured than forty years ago. Nevertheless, it still needs to be processed fast, with support for complex operations.
This combination of requirements, together with the technologies that have emerged in order to address them, is typically referred to as "Big Data." This revolution has led to a completely new way to do business, e.g., develop new products and business models, but also to do science -- which is sometimes referred to as data-driven science or the "fourth paradigm".

Unfortunately, the quantity of data produced and available -- now in the Zettabyte range (that's 21 zeros) per year -- keeps growing faster than our ability to process it. Hence, new architectures and approaches for processing it were and are still needed. Harnessing them must involve a deep understanding of data not only in the large, but also in the small.

The field of databases evolves at a fast pace. In order to be prepared, to the extent possible, to the (r)evolutions that will take place in the next few decades, the emphasis of the lecture will be on the paradigms and core design ideas, while today's technologies will serve as supporting illustrations thereof.

After visiting this lecture, you should have gained an overview and understanding of the Big Data landscape, which is the basis on which one can make informed decisions, i.e., pick and orchestrate the relevant technologies together for addressing each business use case efficiently and consistently.

Content
This course gives an overview of database technologies and of the most important database design principles that lay the foundations of the Big Data universe. The material is organized along three axes: data in the large, data in the small, data in the very small. A broad range of aspects is covered with a focus on how they fit all together in the big picture of the Big Data ecosystem.

- Physical storage (HDFS, S3)
- Logical storage (key-value stores, document stores, column stores, key-value stores, data warehouses)
- Data shapes and models (tables, trees, graphs, cubes)
- An overview of programming languages with a focus on their type systems (SQL, XQuery, MDX)
- The most important query paradigms (selection, projection, joining, grouping, ordering, windowing)
- Paradigms for parallel processing (MapReduce) and technologies (Hadoop, Spark)
- Optimization techniques (functional and declarative paradigms, query plans, rewrites, indexing)
- Applications.

We will also host two guest lectures to get insights from the industry: UBS and Google.

Literature
Papers from scientific conferences and journals. References will be given as part of the course material during the semester.
Literature

[bertsekas] Data Networks
Dimitri Bertsekas, Robert Gallager

[borodin] Online Computation and Competitive Analysis
Allan Borodin, Ran El-Yaniv.
Cambridge University Press, 1998

[bouduc] Network Calculus
J.-Y. Le Boudec, P. Thiran
Springer, 2001

[cassandras] Introduction to Discrete Event Systems
Christos Cassandras, Stéphane Lafortune.

[fiat] Online Algorithms: The State of the Art
A. Fiat and G. Woeginger

D. Hochbaum

[schickinger] Diskrete Strukturen (Band 2: Wahrscheinlichkeitstheorie und Statistik)
T. Schickinger, A. Steger
Springer, Berlin, 2001

[sipser] Introduction to the Theory of Computation
Michael Sipser.

227-0197-00L Wearable Systems I W 6 credits 4G G. Tröster, U. Blanke

Abstract
Context recognition in mobile communication systems like mobile phone, smart watches and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning.
Context comprises the behavior of individuals and of groups, their activities as well as the local and social environment.

Objective
Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our ‘smart phone’ detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our ‘smart phone’ offers us the appropriate services like a personal assistant. Context comprises user's behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.
Context recognition as the crucial function of mobile systems is the main focus of the course. Using MatLab the participants implement and verify the discussed methods also using a smart phone.

Content
Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our ‘smart phone’ detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our ‘smart phone’ offers us the appropriate services like a personal assistant. Context recognition - what is the situation of the user, his activity, his environment, how is he doing, what are his needs - as the central functionality of mobile systems constitutes the focus of the course.

The main topics of the course include
Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarity measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, KNN-Methods, Support Vector Machine, AdaBoost, Deep Learning), clustering (k-means, dbscan, topic models), Recommender Systems, Collaborative Filtering, Crowdsourcing.

The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

Presentations of the PhD students and the visit at the Wearable Computing Lab introduce current research topics and international research projects.

Lecture notes
Language: german/english (depending on the participants)
Lecture notes for all lessons, assignments and solutions.
http://www.ife.ee.ethz.ch/education/wearable_systems_1

Literature
Literature will be announced during the lessons.

Prerequisites / notice
No special prerequisites

227-0447-00L Image Analysis and Computer Vision W 6 credits 3V+1U L. Van Gool, O. Göksel, E. Konukoglu

Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Prerequisites / Notice</th>
</tr>
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<tbody>
<tr>
<td>227-0417-00L</td>
<td>Information Theory I</td>
<td>6</td>
<td>W</td>
<td>4G</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course covers the basic concepts of information theory and of communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.</td>
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<tr>
<td>Objective</td>
<td>The fundamentals of Information Theory including Shannon's source coding and channel coding theorems</td>
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<tr>
<td>Content</td>
<td>The entropy rate of a source. Typical sequences, the asymptotic equi-partition property, the source coding theorem, Huffman coding, Arithmetic coding, channel capacity, the channel coding theorem, the source-channel separation theorem, feedback capacity</td>
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<tr>
<td>Literature</td>
<td>T.M. Cover and J. Thomas, Elements of Information Theory (second edition)</td>
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<tr>
<td>227-0427-00L</td>
<td>Signal and Information Processing: Modeling,</td>
<td>6</td>
<td>W</td>
<td>4G</td>
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<tr>
<td>Filtering,</td>
<td>Learning</td>
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<tr>
<td>Abstract</td>
<td>Fundamentals in signal processing, detection/estimation, and machine learning.</td>
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<tr>
<td>I. Linear signal</td>
<td>Representation and approximation: Hilbert spaces, LMMSE estimation, regularization and sparsity.</td>
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<td>II. Learning</td>
<td>linear functions and filters; kernel methods, neural networks.</td>
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<tr>
<td>Objective</td>
<td>The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.</td>
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<tr>
<td>Part III -</td>
<td>Structured Statistical Models and Message Passing</td>
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<td>Lecture notes</td>
<td>Lecture notes.</td>
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<tr>
<td>Prerequisites /</td>
<td>- local bachelors: course &quot;Discrete-Time and Statistical Signal Processing&quot; (5. Sem.)</td>
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<td>notice</td>
<td>- others: solid basics in linear algebra and probability theory</td>
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<tr>
<td>227-0627-00L</td>
<td>Applied Computer Architecture</td>
<td>6</td>
<td>W</td>
<td>4G</td>
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<tr>
<td>Abstract</td>
<td>This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs.</td>
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<tr>
<td>Objective</td>
<td>Understand the function, the design and the performance modeling of parallel computer systems.</td>
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<tr>
<td>Content</td>
<td>The lecture &quot;Applied Computer Architecture&quot; gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits. Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)? Which architecture is behind the alarm center of the Swiss Railway (SBB)? Which computer architectures are applied for driver assistance systems? Which computer architecture is hidden behind a professional digital audio mixing desk? How can data streams of about 30 TB/s, produced by a protone accelerator, be processed in real time? Can the weather forecast also be processed with GPUs? How can a good computer architecture be found? Which are the driving factors in successful computer architecture design?</td>
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<tr>
<td>Lecture notes</td>
<td>Script and exercises sheets.</td>
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<td>Prerequisites /</td>
<td>Prerequisites:</td>
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<tr>
<td>notice</td>
<td>- others: solid basics in linear algebra and probability theory</td>
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<tr>
<td>252-0206-00L</td>
<td>Visual Computing</td>
<td>8</td>
<td>W</td>
<td>4V+3U</td>
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<tr>
<td>Abstract</td>
<td>This course acquaints students with core knowledge in computer graphics, image processing, multimedia and computer vision. Topics include: Graphics pipeline, perception and camera models, transformation, shading, global illumination, texturing, sampling, filtering, image representations, image and video compression, edge detection and optical flow.</td>
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<tr>
<td>Objective</td>
<td>This course provides an in-depth introduction to the core concepts of computer graphics, image processing, multimedia and computer vision. The course forms a basis for the specialization track Visual Computing of the CS master program at ETH.</td>
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<tr>
<td>Content</td>
<td>Course topics will include: Graphics pipeline, perception and color models, camera models, transformations and projection, projections, lighting, shading, global illumination, texturing, sampling theorem, Fourier transforms, image representations, convolution, linear filtering, diffusion, nonlinear filtering, edge detection, optical flow, image and video compression.</td>
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<tr>
<td>Literature</td>
<td>A script will be handed out for a part of the course. Copies of the slides will be available for download. We will also provide a detailed list of references and textbooks.</td>
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<tr>
<td>252-0417-00L</td>
<td>Randomized Algorithms and Probabilistic Methods</td>
<td>7</td>
<td>W</td>
<td>3V+2U+1A</td>
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<tr>
<td>Abstract</td>
<td>Las Vegas &amp; Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks</td>
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<td>Objective</td>
<td>After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.</td>
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<tr>
<td>Content</td>
<td>Randomized Algorithms are algorithms that &quot;flip coins&quot; to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.</td>
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<td>Lecture notes</td>
<td>Yes.</td>
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<tr>
<td>252-0546-00L</td>
<td>Physically-Based Simulation in Computer Graphics</td>
<td>4</td>
<td>W</td>
<td>2V+1U</td>
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<tr>
<td>Abstract</td>
<td>This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.</td>
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</tbody>
</table>
Objective
This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.

Content
The lecture covers topics in physically-based modeling, such as particle systems, mass-spring models, finite difference and finite element methods. These approaches are used to represent and simulate deformable objects or fluids with applications in animated movies, 3D games and medical systems. Furthermore, the lecture covers topics such as rigid body dynamics, collision detection, and character animation.

Prerequisites / notice
Fundamentals of calculus and physics, basic concepts of algorithms and data structures, basic programming skills in C++. Knowledge on numerical mathematics as well as ordinary and partial differential equations is an asset, but not required.

401-3611-00L Advanced Topics in Computational Statistics

Abstract
This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.

Objective
Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

Content
The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

Lecture notes
Lecture notes.

Prerequisites / notice
We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

401-3627-00L High-Dimensional Statistics

Abstract
"High-Dimensional Statistics" deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.

Objective
Knowledge of methods and basic theory for high-dimensional statistical inference

Content
Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling

Literature

Prerequisites / notice
Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

401-4623-00L Time Series Analysis

Abstract
Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Objective
Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

Content
This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

Literature
Not available

Prerequisites / notice
A list of references will be distributed during the course.

401-3901-00L Mathematical Optimization

Abstract
Mathematical treatment of diverse optimization techniques.

Objective
Advanced optimization theory and algorithms.

Content
1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas' Lemma and infeasibility certificates, duality theory of linear programming.


3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.

4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

402-2203-01L Classical Mechanics

Abstract
A conceptual introduction to theoretical physics: Newtonian mechanics, central force problem, oscillations, Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.

227-1033-00L Neuromorphic Engineering I

Abstract
This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

Objective
Understanding of the characteristics of neuromorphic circuit elements.
Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retina and cochleae for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

Literature
S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

Prerequisites / notice
Particular: The course is highly recommended for those who intend to take the spring semester course ‘Neuromorphic Engineering II’, that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.
The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include:


The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that this is necessary in order to be able to solve actual chemical problems on a computer with quantum chemical methods.

The relativistic re-derivation of all concepts known from (nonrelativistic) quantum mechanics and quantum-chemistry lectures will finally explain the form of all operators in the molecular Hamiltonian - usually postulated rather than deduced. From this, we derive operators needed for molecular spectroscopy (like those required by magnetic resonance spectroscopy). Implications of other assumptions in standard non-relativistic quantum chemistry shall be analyzed and understood, too. Examples are the Born-Oppenheimer approximation and the expansion of the electronic wave function in a set of pre-defined many-electron basis functions (Slater determinants). Overcoming these concepts, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics. Also revisiting the workhorse of quantum chemistry, namely density functional theory, with an emphasis on open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor. It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

Examples are:

| 1) | Operators derived from principles of relativistic quantum mechanics |
| 2) | Operators derived from principles of relativistic quantum mechanics |
| 3) | Klein-Gordon and Dirac equation; the Dirac hydrogen atom |
| 4) | Numerical methods based on the Dirac-Fock-Coulomb Hamiltonian, two-component and scalar relativistic Hamiltonians |
| 5) | Response theory and molecular properties, derivation of property operators, Breit-Pauli-Hamiltonian |
| 6) | Relativistic effects in chemistry and the emergence of spin |
| 7) | Spin in density functional theory |
| 8) | New-electron-correlation theories: Tensor network and matrix product states, the density matrix renormalization group |
| 9) | Quantum chemistry without the Born-Oppenheimer approximation |

A set of detailed lecture notes will be provided, which will cover the whole course.

**Prerequisites / notice**

-Umkehr-Fluiddynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science
-Physics I, II, Environmental Fluid Dynamics

**Objective**

The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that this is necessary in order to be able to solve actual chemical problems on a computer with quantum chemical methods.

The relativistic re-derivation of all concepts known from (nonrelativistic) quantum mechanics and quantum-chemistry lectures will finally explain the form of all operators in the molecular Hamiltonian - usually postulated rather than deduced. From this, we derive operators needed for molecular spectroscopy (like those required by magnetic resonance spectroscopy). Implications of other assumptions in standard non-relativistic quantum chemistry shall be analyzed and understood, too. Examples are the Born-Oppenheimer approximation and the expansion of the electronic wave function in a set of pre-defined many-electron basis functions (Slater determinants). Overcoming these concepts, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics. Also revisiting the workhorse of quantum chemistry, namely density functional theory, with an emphasis on open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor. It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

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| 9) | Quantum chemistry without the Born-Oppenheimer approximation |

A set of detailed lecture notes will be provided, which will cover the whole course.

**Prerequisites / notice**

- Physics I, II, Environmental Fluid Dynamics
- Concepts for non-ideal boundary layer conditions
- Spectral characteristics
- Statistical treatment of turbulence, turbulent transport
The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations. Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.

During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on.

Central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course).

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microflows among others.

Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.

The content of the course includes:

1. Background: Elements of statistical mechanics and kinetic theory:
   Particle's distribution function, Liouville equation, entropy, ensembles; Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation; Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

2. Basics of the Lattice Boltzmann Method and Simulations:
   Minimal kinetic models; lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

3. Hands on:
   Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).

4. Practical issues of LBM for fluid dynamics simulations:
   Lattice Boltzmann simulations of turbulent flows; numerical stability and accuracy.

5. Microwaves:
   Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.

6. Advanced lattice Boltzmann methods:
   Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.

7. Introduction to LB models beyond hydrodynamics:
   Relativistic fluid dynamics; flows with phase transitions.

Lecture notes
Lecture notes on the theoretical parts of the course will be made available. Selected original and review papers are provided for some of the lectures on advanced topics. Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the analysis of realistic reactive flow systems necessitates the use of detailed computer models that can be constructed starting from first principles i.e. thermodynamics, fluid mechanics, chemical kinetics, and heat and mass transport. In this course, the focus will be on combustion theory and modeling. The reacting flow governing equations and the combustion chemistry are firstly reviewed, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Heterogeneous (catalytic) combustion, an area of increased importance in the last years, will be dealt in detail along with its coupling with homogeneous combustion. Finally, approaches for the modeling of turbulent combustion will be presented. Available numerical codes will be used to compute the above described phenomena. Familiarity with numerical methods for the solution of partial differential equations is expected.

The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<td>151-0207-00L</td>
<td>Theory and Modeling of Reactive Flows</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>C. E. Frouzakis, I. Mantzaras</td>
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<td></td>
<td>Abstract</td>
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<td>the analysis of homogeneous gas-phase mixtures,</td>
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<td>laminar diffusion and premixed flames. Catalytic</td>
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<td>chemical kinetics, and heat and mass transport.</td>
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<td>homogeneous gas-phase mixtures, laminar diffusion</td>
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<td>and premixed flames. Heterogeneous (catalytic)</td>
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<td>the solution of partial differential equations</td>
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<th>Course Code</th>
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<tbody>
<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>8</td>
<td>3V+2U+2A</td>
<td>J. M. Buhmann</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>Machine learning algorithms provide analytical</td>
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<td>methods to search data sets for characteristic</td>
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<td>patterns. Typical tasks include the classification</td>
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<td>of data, function fitting and clustering, with</td>
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<td>applications in image and speech analysis,</td>
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<td>bioinformatics and exploratory data analysis.</td>
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<td>important concepts and algorithms for supervised</td>
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<td>and unsupervised learning; reinforce the statistics</td>
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<td>knowledge which is indispensable to solve modeling</td>
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<td>problems under uncertainty. Key concepts are the</td>
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<td>generalization ability of algorithms and</td>
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<td>systematic approaches to modeling and</td>
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<td>regularization. A machine learning project will</td>
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<td>provide an opportunity to test the machine</td>
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<td>learning algorithms on real world data.</td>
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<td>The theory of fundamental machine learning</td>
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<td>concepts is presented in the lecture, and</td>
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<td>illustrated with relevant applications. Students</td>
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<td>can deepen their understanding by solving both</td>
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<td>pen-and-paper and programming exercises, where</td>
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<td>they implement and apply famous algorithms to</td>
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Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non-parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Prerequisites / notice</th>
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<tbody>
<tr>
<td>Handouts</td>
<td>NEW course</td>
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</table>

Literature


Prerequisites / notice

The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments.

Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

Case Studies

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-3667-66L</td>
<td>Case Studies Seminar (Autumn Semester 2016)</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>V. C. Gradinaru, R. Hiptmair, M. Reiher</td>
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<tr>
<td>Abstract</td>
<td>In the CSE Case Studies Seminar invited</td>
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<td>speakers from ETH, from other universities</td>
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<td>as well as from industry give a talk on an</td>
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<td>applied topic. Beside of attending the scientific</td>
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GESS Science in Perspective

Science in Perspective

see Science in Perspective: Type A: Enhancement of Reflection Capability

Recommended Science in Perspective (Type B) for D-MATH.

Science in Perspective

see Science in Perspective: Language Courses ETH/UZH

Bachelor’s Thesis

see Science in Perspective: Language Courses ETH/UZH

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<th>ECTS</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2000-00L</td>
<td>Scientific Works in Mathematics</td>
<td>O</td>
<td>0</td>
<td></td>
<td>E. Kowalski</td>
</tr>
<tr>
<td>Target</td>
<td>audience: Third year Bachelor students:</td>
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<td></td>
<td>Master students: are asked to receive</td>
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<td>an adequate training in working</td>
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<td>scientifically.</td>
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</tbody>
</table>
Abstract
Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)

Objective
Learn the basic standards of scientific works in mathematics.

Content
- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519

Prerequisites / notice
This course is completed by the optional course “Recherchieren in der Mathematik” (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

401-3990-01L Bachelor's Thesis
No direct enrolment to this course unit in myStudies. Please fill in the online application form. Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html
(Afterwards the enrolment will be done by the Study Administration.)

Abstract
The BSc thesis concludes the curriculum. In their BSc thesis, students should demonstrate their ability to carry out independent, structured scientific work. The purpose of the BSc thesis is to deepen knowledge in a certain subject and to bring students into closer contact with applications in an existing computational group. The BSc thesis requires approximately 160 hours of work.

Objective
In their Bsc thesis students should demonstrate their ability to carry out independent, structured scientific work. The purpose is to deepen knowledge in a certain subject and to enable students to collaborate in an existing scientific group to take a computational approach to problems encountered in applications.

Prerequisites / notice
The supervisor responsible for the Bachelor thesis defines the task and determines the start and the submission date. The Bachelor thesis concludes with a written report. The Bachelor thesis is graded.

Colloquia

Computational Science and Engineering Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Compulsory</th>
<th>Eligible for credits and recommended</th>
<th>Eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>E-</td>
<td>Z</td>
<td>Dr</td>
</tr>
<tr>
<td>W+</td>
<td>E-</td>
<td>Courses outside the curriculum</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

| V    | lecture   | P        | practical/laboratory course |
| G    | lecture with exercise | A | independent project |
| U    | exercise  | D        | diploma thesis |
| S    | seminar   | R        | revision course / private study |
| K    | colloquium|          |                         |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH).

In the colloquium, participants will be in a position to:
- critically question the performance assessment that they employ in practice and professionalise it still further.
- evaluate examples of scientifically-developed tests in their application context.
- describe the scientific fundamentals of test theory and test structure.
- establish the scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.

Dazu sind folgende Leistungen zu erbringen:
- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)
- Weitere Literatur wird in der Lehrveranstaltung genannt.
- weitere Angaben zu den Leistungsanforderungen werden im Rahmen der Startveranstaltung abgegeben und erläutert.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
<tr>
<td></td>
<td>This lecture is only apt for students who intend to enrol in the programs &quot;Teaching Diploma&quot; or &quot;Teaching Certificate&quot;. It is about learning in childhood and adolescence.</td>
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<td></td>
<td>Abstract</td>
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<td></td>
<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<td>Objective</td>
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<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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<td></td>
<td>Content</td>
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<td></td>
<td>Thematische Schwerpunkte:</td>
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<td></td>
<td>Lernen als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzentwicklung unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen; Intelligenztheorien, Geschlechtsunterschiede beim Lernen</td>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0240-03L</td>
<td>Introduction to Test Theory and Test Construction in Educational Contexts (University of Zürich)</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>University lecturers</td>
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<tr>
<td></td>
<td>Enrolment only possible with Teaching Diploma or DC matriculation.</td>
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<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 200a968</td>
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<td>Mind the enrolment deadlines at UZH:</td>
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<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<td></td>
<td>Abstract</td>
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<td></td>
<td>In this seminar, students will establish the scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.</td>
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<td>Objective</td>
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<td></td>
<td>At the end of the seminar, participants will be in a position to</td>
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<td>- describe the scientific fundamentals of test theory and test structure.</td>
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<td>- evaluate examples of scientifically-developed tests in their application context.</td>
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<td>- if necessary, critically question the performance assessment that they employ in practice and professionalise it still further.</td>
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<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Die konkreten Inhalte des Seminars ergeben sich aufgrund der Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:</td>
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<td>- Testentwicklung</td>
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<td>- Gütekriterien von Tests</td>
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<td>- Aufgabenkonstruktion</td>
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<td>- Datenauswertung</td>
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<td>- Rasch-Modell</td>
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<td>- Internationale Vergleichstests</td>
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<td>- Zulassungstests</td>
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<td>Lecture notes</td>
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<td></td>
<td>Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören auch die Handouts der verschiedenen, studentischen Vorträge.</td>
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<td>Literature</td>
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<td>Als Grundlagenliteratur werden folgende Werke empfohlen:</td>
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<td></td>
<td>- weitere Literatur wird in der Lehrveranstaltung genannt.</td>
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<td></td>
<td>Prerequisites / notice</td>
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<td>Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen:</td>
<td></td>
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<tr>
<td></td>
<td>- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)</td>
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<td>- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung</td>
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<td>- Referat (RE)</td>
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<td>- Schreiben einer schriftlichen Arbeit</td>
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<td></td>
<td>weitere Angaben zu den Leistungsanforderungen werden im Rahmen der Startveranstaltung abgegeben und erläutert.</td>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0240-15L</td>
<td>Colloquium on the Science of Learning and Instruction</td>
<td>W</td>
<td>1</td>
<td>1K</td>
<td>E. Stern, P. Greutmann, further lecturers</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH).</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.</td>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4 W</td>
<td>W</td>
<td>2</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann,</td>
</tr>
</tbody>
</table>
Abstract

Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons

(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

851-0242-06L Cognitively Activating Instructions in MINT Subjects W 2 credits 2S R. Schumacher

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective

- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites / notice

Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

851-0242-08L Research Methods in Educational Science W 1 credit 1S P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler

Number of participants limited to 30.

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract

Literature from the learning sciences is critically discussed with a focus on research methods. At the meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objective

- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

851-0242-07L Human Intelligence W 1 credit 1S E. Stern, P. Edelsbrunner, B. Rütsche

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

Number of participants limited to 30.

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract

The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

Objective

- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9908-00L</td>
<td>Teaching Internship Including Examination Lessons Teaching Internship Computational Science and Engineering</td>
<td>W</td>
<td>6 credits</td>
<td>13P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

Numbers only for students who enrolled from HS 2011 on into TC.

The teaching internship can just be visited if all other courses of TC are completed.

Repetition of the teaching internship is excluded even if the examination lessons are to be repeated.

Abstract

Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Objective

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils’ work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.
Unterlagen und Folien werden zur Verfügung gestellt.

J. Hromkovic

Subject Didactics of Computer Science I

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in
3G

The objective is for the students:


The unit "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and
of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the
didactics methods and techniques that are introduced at the beginning of the semester.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior
knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written
way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding
German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

Content

The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen
topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world
as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and
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German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

Content

The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen
topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world
as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and
of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the
didactics methods and techniques that are introduced at the beginning of the semester.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior
knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written
way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding
German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.
Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.

Abstract

Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.

Content

The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classic game-theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization.
- Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the 'Price of Anarchy').
- Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium.
- Selected current research topics, such as Google's Sponsored Search Auction, the U.S. FCC Spectrum Auction, Kidney Exchange.

Further Subject Didactics
Prerequisites / notice

Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

252-0417-00L Randomized Algorithms and Probabilistic Methods  W  7 credits  3V+2U+1A  A. Steger, E. Welzl

Abstract
Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks.

Objective
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Content
Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Literature

Computational Science and Engineering TC - Key for Type

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<thead>
<tr>
<th>Key</th>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E- Recommended, not eligible for credits</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z Courses outside the curriculum</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr Suitable for doctorate</td>
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Key for Hours

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<th>Key</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Computational Science and Engineering Master

Core Courses

Two core courses out of three must be attended and examinations must be taken in both.

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>

Abstract
This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.

Objective
At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis. In addition, the course is intended to stimulate the students' curiosity to explore the field of computer graphics on their own.

Content
This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.

Lecture notes
Written information will be supplied.

Prerequisites
No prerequisites.

ECTS
30

Number Title Type ECTS Hours Lecturers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-7851-00L</td>
<td>Theoretical Astrophysics (University of Zurich)</td>
<td>W</td>
<td>10</td>
<td>4V+2U</td>
<td>R. Teyssier</td>
</tr>
</tbody>
</table>

Abstract
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Prerequisites
- Fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, programming skills in C++, Visual Computing course recommended.
- The programming assignments will be in C++. This will not be taught in the class.

Fields of Specialization

Astrophysics

Introduction to astrophysics (preferred but not obligatory).

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<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-7855-00L</td>
<td>Computational Astrophysics (University of Zurich)</td>
<td>W</td>
<td>6</td>
<td>2V</td>
<td>L. M. Mayer</td>
</tr>
</tbody>
</table>

Abstract
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Prerequisites
- No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
- UZH Module Code: AST245

Objective
Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programmes.

Content
1. Integration of ODE, Hamiltonians and Symplectic integration techniques, time adaptivity, time reversibility
2. Large-N gravity calculation, collisionless N-body systems and their simulation
3. Fast Fourier Transform and spectral methods in general
4. Eulerian Hydrodynamics: Upwinding, Riemann solvers, Limiters
5. Lagrangian Hydrodynamics: The SPH method
6. Resolution and instabilities in Hydrodynamics
7. Initial Conditions: Cosmological Simulations and Astrophysical Disks
8. Physical Approximations and Methods for Radiative Transfer in Astrophysics

Literature
- Galactic Dynamics (Binney & Tremaine, Princeton University Press),
- Computer Simulation using Particles (Hockney & Eastwood CRC press),
- Targeted journal reviews on computational methods for astrophysical fluids (SPH, AMR, moving mesh)

Prerequisites
- Some knowledge of UNIX, scripting languages (see www.physik.uzh.ch/lectures/informatik/python/ as an example), some prior experience programming, knowledge of C, C++ beneficial

Physics of the Atmosphere

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td>701-0023-00L</td>
<td>Atmosphere</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>H. Wernli, E. M. Fischer, T. Peter</td>
</tr>
</tbody>
</table>

Abstract
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Objective
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere - mesosphere - thermosphere - exosphere.

Content
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Lecture notes
Written information will be supplied.
Seminar in Physics of the Atmosphere for CSE
Lecturers

**Dynamics of Large-Scale Atmospheric Flow**

**Objective**
Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts.

- Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

**Content**
- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

**Literature**

**Prerequisites / notice**
Umwelt-Fluiddynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

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**Seminar in Physics of the Atmosphere for CSE**

**Objective**
The students of this course are provided with an introduction into presentation techniques (talks and posters) and practice this knowledge by making an oral presentation about a classical or recent scientific publication.

**Content**
- Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

**Literature**

**Prerequisites / notice**
Physics I, II, Environmental Fluid Dynamics

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**Chemistry**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0004-00L</td>
<td>Computer Simulation in Chemistry, Biology and Physics</td>
<td>W</td>
<td>7</td>
<td>4G</td>
<td>P. H. Hünenberger</td>
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<tr>
<td></td>
<td>Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.</td>
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<td>For more information: <a href="http://www.csms.ethz.ch/education/CSCBP">www.csms.ethz.ch/education/CSCBP</a></td>
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<td></td>
<td>Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.</td>
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<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<tr>
<td></td>
<td>Available (copies of powerpoint slides distributed before each lecture)</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.</td>
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<td>For more information about the lecture: <a href="http://www.csms.ethz.ch/education/CSCBP">www.csms.ethz.ch/education/CSCBP</a></td>
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</table>

| 529-0003-00L   | Advanced Quantum Chemistry                                                                | W    | 7    | 3G    | M. Reiher, S. Knecht   |
|                | Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems with a computer. Examples are: |
|                | * Operators derived from principles of relativistic quantum mechanics                      |      |      |       |                         |
|                | * Relativistic effects + methods of relativistic quantum chemistry                       |      |      |       |                         |
|                | * Open-shell molecules + spin-density functional theory                                   |      |      |       |                         |
|                | * New electron-correlation theories                                                      |      |      |       |                         |
|                | For more information about the lecture: www.csms.ethz.ch/education/CSCBP                  |      |      |       |                         |
### Objective

The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that this is necessary in order to be able to solve actual chemical problems on a computer with quantum chemical methods.

The relativistic re-derivation of all concepts known from (nonrelativistic) quantum mechanics and quantum-chemistry lectures will finally explain the form of all operators in the molecular Hamiltonian - usually postulated rather than deduced. From this, we derive operators needed for molecular spectroscopy (like those required by magnetic resonance spectroscopy). Implications of other assumptions in standard non-relativistic quantum chemistry shall be analyzed and understood, too. Examples are the Born-Oppenheimer approximation and the expansion of the electronic wave function in a set of pre-defined many-electron basis functions (Slater determinants). Overcoming these concepts, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics. Also revisiting the workhorse of quantum chemistry, namely density functional theory, with an emphasis on open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor. It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

### Content

1. Introductory lecture: basics of quantum mechanics and quantum chemistry
2. Einstein's special theory of relativity and the (classical) electromagnetic interaction of two charged particles
3. Klein-Gordon and Dirac equation; the Dirac hydrogen atom
4. Numerical methods based on the Dirac-Fock-Coulomb Hamiltonian, two-component and scalar relativistic Hamiltonians
5. Response theory and molecular properties, derivation of property operators, Breit-Pauli-Hamiltonian
6. Relativistic effects in chemistry and the emergence of spin
7. Spin in density functional theory
8. New electron-correlation theories: Tensor network and matrix product states, the density matrix renormalization group
9. Quantum chemistry without the Born-Oppenheimer approximation

A set of detailed lecture notes will be provided, which will cover the whole course.

### Literature

2. F. Schwalb: Quantenmechanik für Fortgeschrittene (QM II), Springer-Verlag, 1997 (english version available: F. Schwalb, Advanced Quantum Mechanics)


http://pubs.rsc.org/en/Content/ArticleLanding/2011/CP/c0cp01883j


http://pra.aps.org/abstract/PRA/v83/i5/e052512

Note also the standard textbooks:

- A) N. Szabo, N.S. Ostlund. Verlag, Dover Publications
- B) I. N. Levine, Quantum Chemistry, Pearson

### Prerequisites / notice

Strongly recommended (preparatory) courses are: quantum mechanics and quantum chemistry

### Fluid Dynamics

#### 401-5940-00L Seminar in Chemistry for CSE

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0103-00L</td>
<td>Fluid Dynamics II</td>
<td>O</td>
<td>3</td>
<td>2+1U</td>
<td>P. Jenny</td>
</tr>
</tbody>
</table>

**Abstract**

The student will carry out a literature study on a topic of his or her liking or suggested by the supervisor in the area of computer simulation in chemistry, the results of which are to be presented both orally and in written form.

For more information: www.csms.ethz.ch/education/RW

#### 151-0109-00L Turbulent Flows

**Prerequisites / notice**

Analysis I/II, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0109-00L</td>
<td>Turbulent Flows</td>
<td>W</td>
<td>4</td>
<td>2+1U</td>
<td>P. Jenny</td>
</tr>
</tbody>
</table>

**Abstract**

- Laminar and turbulent flows, instability and origin of turbulence - Statistical description: averaging, turbulent energy, dissipation, closure problem - Scalings: Homogeneous isotropic turbulent correlations, Fourier representation, energy spectrum - Free turbulence: wake, jet, mixing layer - Wall turbulence: Channel and boundary layer - Computation and modelling of turbulent flows

**Objective**

Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation and elements of turbulence modelling
Content
- Properties of laminar, transitional and turbulent flows.
- Origin and control of turbulence. Instability and transition.
- Statistical description, averaging, equations for mean and fluctuating quantities, closure problem.
- Scalings, homogeneous isotropic turbulence, energy spectrum.
- Turbulent free shear flows. Jet, wake, mixing layer.
- Wall-bounded turbulent flows.
- Turbulent flow computation and modeling.

Lecture notes
Lecture notes are available

Literature

151-0182-00L Fundamentals of CFD Methods

Abstract
This course is focused on providing students with the knowledge and understanding required to develop simple computational fluid dynamics (CFD) codes to solve the incompressible Navier-Stokes equations and to critically assess the results produced by CFD codes.

Objective
1. Students know and understand basic numerical methods used in CFD in terms of accuracy and stability.
2. Students have a basic understanding of a typical simple CFD code.
3. Students understand how to assess the numerical and physical accuracy of CFD results.

Content
1. Governing and model equations. Brief review of equations and properties
2. Overview of basic concepts: Overview of discretization process and its consequences
3. Overview of numerical methods: Finite-difference and finite-volume methods
4. Analysis of spatially discrete equations: Consistency, accuracy, stability, convergence of semi-discrete methods
5. Time-integration methods: LMS and RK methods, consistency, accuracy, stability, convergence
6. Analysis of fully discrete equations: Consistency, accuracy, stability, convergence of fully discrete methods
7. Solution of one-dimensional advection equation: Motivation for and consequences of upwinding, Godunov's theorem, TVD methods, DRP methods
8. Solution of two-dimensional advection equation: Dimension-by-dimension methods, dimensional splitting, multidimensional methods
9. Solution of one- and two-dimensional diffusion equations: Implicit methods, ADI methods
10. Solution of one-dimensional advection-diffusion equation: Numerical vs physical viscosity, boundary layers, non-uniform grids
11. Solution of incompressible Navier-Stokes equations: Incompressibility constraint and consequences, conditional-step and pressure-correction methods
12. Solution of incompressible Navier-Stokes equations on unstructured grids

Lecture notes
The course is based mostly on notes developed by the instructor.

Literature
Literature: There is no required textbook. Suggested references are:

Prerequisites / notice
Prior knowledge of fluid dynamics, applied mathematics, basic numerical methods, and programming in Fortran and/or C++ (knowledge of MATLAB is "not" sufficient).

151-0105-00L Quantitative Flow Visualization

Abstract
The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.

Objective
1. Students have a basic understanding of a typical simple CFD code.
2. Students know and understand basic numerical methods used in CFD in terms of accuracy and stability.

Content
1. Overview of numerical methods: Finite-difference and finite-volume methods
2. Analysis of spatially discrete equations: Consistency, accuracy, stability, convergence of semi-discrete methods
3. Analysis of time-integration methods: LMS and RK methods, consistency, accuracy, stability, convergence
4. Analysis of fully discrete equations: Consistency, accuracy, stability, convergence of fully discrete methods
5. Solution of one-dimensional advection equation: Motivation for and consequences of upwinding, Godunov's theorem, TVD methods, DRP methods
6. Solution of two-dimensional advection equation: Dimension-by-dimension methods, dimensional splitting, multidimensional methods
7. Solution of one- and two-dimensional diffusion equations: Implicit methods, ADI methods
8. Solution of one-dimensional advection-diffusion equation: Numerical vs physical viscosity, boundary layers, non-uniform grids
9. Solution of incompressible Navier-Stokes equations: Incompressibility constraint and consequences, conditional-step and pressure-correction methods
10. Solution of incompressible Navier-Stokes equations on unstructured grids

Lecture notes
available

Prerequisites / notice
Prerequisites: Fluid dynamics I, Numerical Mathematics, programming skills.
Language: German on request.

151-0213-00L Fluid Dynamics with the Lattice Boltzmann Method

Abstract
The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations.

Objective
1. Students have a basic understanding of a typical simple CFD code.
2. Students know and understand basic numerical methods used in CFD in terms of accuracy and stability.

Content
1. Governing and model equations. Brief review of equations and properties
2. Overview of basic concepts: Overview of discretization process and its consequences
3. Overview of numerical methods: Finite-difference and finite-volume methods
4. Analysis of spatially discrete equations: Consistency, accuracy, stability, convergence of semi-discrete methods
5. Time-integration methods: LMS and RK methods, consistency, accuracy, stability, convergence
6. Analysis of fully discrete equations: Consistency, accuracy, stability, convergence of fully discrete methods
7. Solution of one-dimensional advection equation: Motivation for and consequences of upwinding, Godunov's theorem, TVD methods, DRP methods
8. Solution of two-dimensional advection equation: Dimension-by-dimension methods, dimensional splitting, multidimensional methods
9. Solution of one- and two-dimensional diffusion equations: Implicit methods, ADI methods
10. Solution of one-dimensional advection-diffusion equation: Numerical vs physical viscosity, boundary layers, non-uniform grids
11. Solution of incompressible Navier-Stokes equations: Incompressibility constraint and consequences, conditional-step and pressure-correction methods
12. Solution of incompressible Navier-Stokes equations on unstructured grids

Lecture notes
available

Prerequisites / notice
Prerequisites: Fluid dynamics I, Numerical Mathematics, programming skills.
Language: German on request.

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microflows among others.

Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.
The course builds upon three parts:

I. Elementary kinetic theory and lattice Boltzmann simulations introduced on simple examples.

II. Theoretical basis of statistical mechanics and kinetic equations.

III. Lattice Boltzmann method for real-world applications.

The content of the course includes:

1. Background: Elements of statistical mechanics and kinetic theory:
   Particle’s distribution function, Liouville equation, entropy, ensembles; Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation;
   Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

2. Basics of the Lattice Boltzmann Method and Simulations:
   Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

3. Hands on:
   Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).

4. Practical issues of LBM for fluid dynamics simulations:
   Lattice Boltzmann simulations of turbulent flows;
   numerical stability and accuracy.

5. Microflow:
   Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.

6. Advanced lattice Boltzmann methods:
   Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.

7. Introduction to LB models beyond hydrodynamics:
   Relativistic fluid dynamics; flows with phase transitions.

Lecture notes
Lecture notes on the theoretical parts of the course will be made available.
Selected original and review papers are provided for some of the lectures on advanced topics.
Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.

Prerequisites / notice
The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.

151-0207-00L Theory and Modeling of Reactive Flows W 4 credits 3G C. E. Frouzakis, I. Mantzaras

Objective Content
The course first reviews the governing equations and combustion chemistry, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic combustion and its coupling with homogeneous combustion are dealt in detail, and turbulent combustion modeling approaches are presented. Available numerical codes will be used for modeling.

401-5950-00L Seminar in Fluid Dynamics for CSE W 4 credits 2S P. Jenny, T. Rösgen

Objective
Enlarged knowledge and practical abilities in fundamentals and applications of Computational Fluid Dynamics

Prerequisites / notice
Enlarged knowledge and practical abilities in fundamentals and applications of Computational Fluid Dynamics
Contact Prof. P. Jenny or Prof. T. Rösgen before the beginning of the semester

Systems and Control

Number Title Type ECTS Hours Lecturers
227-0103-00L Control Systems W 6 credits 2+2U F. Dörfler

Abstract
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Objective

Literature
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the basics of signals and systems. Apply this knowledge to problems in the homework assignments and programming exercises.

### Dynamic Programming and Optimal Control
2V+2U
- Covers the fundamental concepts of Dynamic Programming & Optimal Control.
- Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

### Linear System Theory
6 credits
- Rings, fields and linear spaces, normed linear spaces and inner product spaces.
- Ordinary differential equations, existence and uniqueness of solutions.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Stability and stabilization, observers, state and output feedback, separation principle.
- Realization theory.

### Machine Learning
8 credits
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

### Signals and Systems I
4 credits
- Introduction to mathematical signal processing and system theory.

### Signals and Systems II
6 credits
- Dimension reduction: principal component analysis (PCA) and beyond
- Dimension reduction: principal component analysis (PCA) and beyond

### Seminar in Systems and Control for CSE
4 credits
- Rings, fields and linear spaces, normed linear spaces and inner product spaces.
- Ordinary differential equations, existence and uniqueness of solutions.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Stability and stabilization, observers, state and output feedback, separation principle.
- Realization theory.

### Machine Learning
4 credits
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond
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<th>Number</th>
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<tbody>
<tr>
<td>151-0601-00L</td>
<td>Theory of Robotics and Mechatronics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Korb, S. Stoeter, B. Nelson</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Its a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.</td>
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<tr>
<td>Objective</td>
<td>Robots is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.</td>
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<tr>
<td>Content</td>
<td>An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.</td>
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<tr>
<td>Lecture notes</td>
<td>The course will be taught in English.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Available.</td>
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<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>8</td>
<td>3V+2U+2A</td>
<td>J. M. Buhmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.</td>
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<tr>
<td>Objective</td>
<td>Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.</td>
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<tr>
<td>Content</td>
<td>The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.</td>
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<tr>
<td>Lecture notes</td>
<td>No lecture notes, but slides will be made available on the course webpage.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.</td>
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<tr>
<td>263-5902-00L</td>
<td>Computer Vision</td>
<td>W</td>
<td>6</td>
<td>3V+1U+1A</td>
<td>L. Van Gool, V. Ferrari, A. Geiger</td>
</tr>
<tr>
<td>Abstract</td>
<td>The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.</td>
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<tr>
<td>Objective</td>
<td>The objectives of this course are: 1. To introduce the fundamental problems of computer vision. 2. To introduce the main concepts and techniques used to solve those. 3. To enable participants to implement solutions for reasonably complex problems. 4. To enable participants to make sense of the computer vision literature.</td>
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<td>Content</td>
<td>Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition</td>
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<tr>
<td>Prerequisites / notice</td>
<td>It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.</td>
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<tbody>
<tr>
<td>151-0563-01L</td>
<td>Dynamic Programming and Optimal Control</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>R. D’Andrea</td>
</tr>
<tr>
<td>Objective</td>
<td>Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.</td>
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<tr>
<td>Literature</td>
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<td>Prerequisites / notice</td>
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<tr>
<td>151-0851-00L</td>
<td>Robot Dynamics</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>M. Hutter, R. Siegwart, T. Stastry</td>
</tr>
<tr>
<td>Abstract</td>
<td>We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.</td>
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<tr>
<td>Objective</td>
<td>The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.</td>
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Content

The course consists of three parts: First, we will refresh and deepen the student's knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotics systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

Prerequisites / notice

The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.

401-5860-00L Seminar in Robotics for CSE

Abstract

This course provides an opportunity to familiarize yourself with the advanced topics of robotics and mechatronics research. The study plan has to be discussed with the lecturer based on your specific interests and/or the relevant seminar series such as the IRIS's Robotics Seminars and BI/RONZ lectures, for example.

Objective

The students are familiar with the challenges of the fascinating and interdisciplinary field of Robotics and Mechatronics. They are introduced in the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.

Content

This 4 ECTS course requires each student to discuss a study plan with the lecturer and select minimum 10 relevant scientific publications to read through, or attend 5-10 lectures of the public robotics oriented seminars (e.g. Public robotics seminars such as the IRIS's Robotics Seminars http://www.iris.ethz.ch/iris/series/, and BI/RONZ lectures http://www.birl.ethz.ch/bironz/index are good examples). At the end of semester, the results should be presented in an oral presentation and summarized in a report, which takes the discussion of the presentation into account.

Physics

For the field of specialization ‘Physics’ basic knowledge in quantum mechanics is required.

402-0809-00L Introduction to Computational Physics

Abstract

This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell’s equation), Monte Carlo simulations, percolation, phase transitions.

Content


402-0205-00L Quantum Mechanics I

Abstract

Introduction to non-relativistic single-particle quantum mechanics. In particular, the basic concepts of quantum mechanics, such as the quantisation of classical systems, wave functions and the description of observables as operators on a Hilbert space, and the formulation of symmetries will be discussed. Basic phenomena will be analysed and illustrated by generic examples.

Objective

Introduction to single-particle quantum mechanics. Familiarity with basic ideas and concepts (quantisation, operator formalism, symmetries, perturbation theory) and generic examples and applications (bound states, tunneling, scattering states, in one- and three-dimensional settings). Ability to solve simple problems.

Content

Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), symmetries (translations, rotations), quantum mechanics in one dimension, spherically symmetric problems in three dimensions, scattering theory, perturbation theory, variational techniques, spin, addition of angular momenta, relation between QM and classical physics.

401-5810-00L Seminar in Physics for CSE

Abstract

In this seminar the students present a talk on an advanced topic in modern theoretical or computational physics.

Computational Finance

For the field of specialization ‘Computational Finance’ basic knowledge in mathematical finance is required.

401-3913-01L Mathematical Foundations for Finance

Abstract

First introduction to main modelling ideas and mathematical tools from mathematical finance

Objective

This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

Content

Topics to be covered include

- financial market models in finite discrete time
- absence of arbitrage and martingale measures
- valuation and hedging in complete markets
- basics about Brownian motion
- stochastic integration
- stochastic calculus: Itô’s formula, Girsanov transformation, Itô’s representation theorem
- Black-Scholes formula

Lecture notes

Lecture notes will be submitted at the beginning of the course.

Literature

Prerequisites / notice

Prerequisites: Results and facts from probability theory as in the book “Probability Essentials” by J. Jacod and P. Protter will be used freely. Especially participants without a direct mathematics background are strongly advised to familiarise themselves with those tools before (or very quickly during) the course. (A possible alternative to the above English textbook are the (German) lecture notes for the standard course “Wahrscheinlichkeitsrechnung”.)

For those who are not sure about their background, we suggest to look at the exercises in Chapters 8, 9, 22-25, 28 of the Jacod/Protter book. If these pose problems, you will have a hard time during the course. So be prepared.
Equations
Alternative course title: "Computational Methods for Quantitative Finance: Monte Carlo and Sampling Methods"

Abstract
Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

Objective
The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Content
- Generation of random numbers
- Monte Carlo methods for the numerical integration of random variables
- Stochastic processes and Brownian motion
- Stochastic ordinary differential equations (SODEs)
- Numerical approximations of SODEs
- Multilevel Monte Carlo methods for SODEs
- Applications to computational finance: Option valuation

Lecture notes
Lecture Notes are available in the lecture homepage (please follow the link in the Learning materials section).

Literature

Prerequisites / notice
Prerequisites:
- Mandatory: Probability and measure theory, basic numerical analysis and basics of MATLAB programming.
- a) mandatory courses: Elementary Probability, Probability Theory I.
- b) recommended courses: Stochastic Processes.

Start of lectures: Wednesday, September 21, 2016
For more details, please follow the link in the Learning materials section.

401-8905-00L Financial Engineering (University of Zurich) W 4.5 credits 3G University lecturers

Abstract
This lecture is intended for students who would like to learn more on equity derivatives modelling and pricing.

Objective
Quantitative models for European option pricing (including stochastic volatility and jump models), volatility and variance derivatives, American and exotic options.

Content
After introducing fundamental concepts of mathematical finance including no-arbitrage, portfolio replication and risk-neutral measure, we will present the main models that can be used for pricing and hedging European options e.g. Black-Scholes model, stochastic and jump-diffusion models, and highlight their assumptions and limitations. We will cover several types of derivatives such as European and American options, Barrier options and Variance Swaps. Basic knowledge in probability theory and stochastic calculus is required. Besides attending class, we strongly encourage students to stay informed on financial matters, especially by reading daily financial newspapers such as the Financial Times or the Wall Street Journal.

Lecture notes
Script.

Prerequisites / notice
Basic knowledge of probability theory and stochastic calculus. Asset Pricing.

401-5820-00L Seminar in Computational Finance for CSE W 4 credits 2S J. Teichmann

Content
We aim to comprehend recent and exciting research on the nature of stochastic volatility: an extensive econometric research [4] lead to new insights on stochastic volatility, in particular that very rough fractional processes of Hurst index about 0.1 actually provide very attractive models. Also from the point of view of pricing [1] and microfoundations [2] these models are very convincing.

More precisely each student is expected to work on one specified task consisting of a theoretical part and an implementation with financial data, whose results should be presented in a 45 minutes presentation.

Literature
### Electromagnetics

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<tr>
<td>227-0110-00L</td>
<td>Advanced Electromagnetic Waves</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>P. Leuchtmann</td>
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</table>

**Abstract**
This course provides advanced knowledge of electromagnetic waves in linear materials including negative index and other non classical materials.

**Objective**
The behavior of electromagnetic waves both in free space and in selected environments including stratified media, material interfaces and waveguides is understood. Material models in the time harmonic regime including negative index and plasmonic materials are clarified.

**Content**
Description of generic time harmonic electromagnetic fields; the role of the material in Maxwell's equations; energy transport and power loss mechanism; EM-waves in homogeneous space: ordinary and evanescent plane waves, cylindrical and spherical waves, "complex origin"-waves and beams; EM-waves in stratified media; generic guiding mechanism for EM waves; classical wave guides, dielectric wave guides.

**Lecture notes**
A script including animated wave representations is provided in electronic form.

**Literature**
See literature list in the script.

**Prerequisites / notice**
The lecture is taught in German while both the script and the viewgraphs are in English.

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<tr>
<td>227-0301-00L</td>
<td>Optical Communication Fundamentals</td>
<td>W</td>
<td>6</td>
<td>2V+1U+1P</td>
<td>J. Leuthold</td>
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**Abstract**
The path of an analog signal in the transmitter to the digital world in a communication link and back to the analog world at the receiver is discussed. The lecture covers the fundamentals of all important optical and optoelectronic components in a fiber communication system.

**Objective**
An in-depth understanding on how information is transmitted from source to destination. Also the mathematical framework to describe the important elements will be passed on. Students attending the lecture will further get engaged in critical discussion on societal, economical and environmental aspects related to the on-going exponential growth in the field of communications.

**Content**
* Chapter 1: Introduction: Analog/Digital conversion, The communication channel, Shannon channel capacity, Capacity requirements.
* Chapter 4: The Receiver: Photodiodes, Receiver noise, Detector schemes (direct detection, coherent detection), Bit-error ratios and error estimations.
* Chapter 5: Digital Signal Processing Techniques: Digital signal processing in a coherent receiver, Error detection techinques, Error correction coding.
* Chapter 6: Pulse Shaping and Multiplexing Techniques: WDM/FDM, TDM, OFDM, Nyquist Multiplexing, OCDMA.
* Chapter 7: Optical Amplifiers : Semiconductor Optical Amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers.

**Lecture notes**
Lecture notes are handed out.

**Literature**
Govind P. Agrawal; "Fiber-Optic Communication Systems"; Wiley, 2010

**Prerequisites / notice**

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<tr>
<td>401-5870-00L</td>
<td>Seminar in Electromagnetics for CSE</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>C. Hafner, J. Leuthold</td>
</tr>
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</table>

**Abstract**
Various topics of electromagnetics, including electromagnetic theory, computational electromagnetics, electromagnetic wave propagation, applications from statics to optics. Traditional problems such as antennas, electromagnetic scattering, waveguides, resonators, etc. as well as modern topics such as photonic crystals, metamaterials, plasmonics, etc. are considered.

**Objective**
Knowledge of the fundamentals of electromagnetic theory, development and application of numerical methods for solving Maxwell equations, analysis and optimal design of electromagnetic structures

### Geophysics

**Recommended combinations:**
Subject 1 + Subject 2
Subject 1 + Subject 3
Subject 2 + Subject 3
Subject 3 + Subject 4
Subject 5 + Subject 6
Subject 5 + Subject 4
The goal of this course is to learn and understand few principal partial differential equations (conservation laws) that are applicable for analysing and modelling of any continuum including the Earth's mantle, core, atmosphere and ocean. The course will provide step-by-step introduction into the mathematical structure, physical meaning and analytical solutions of the equations. The course has a particular focus on solid Earth applications.

### Objective
The goal of this course is to learn and understand few principal partial differential equations (conservation laws) that are applicable for analysing and modelling of any continuum including the Earth's mantle, core, atmosphere and ocean. By the end of the course, students should be able to write, explain and apply the equations for simple analytical cases. Numerical solving of these equations will be discussed in the Numerical Modelling I and II course running in parallel.

### Content
A provisional week-by-week schedule (subject to change) is as follows:

#### Week 1: The continuity equation
- Definition of a geological media as a continuum. Field variables used for the representation of a continuum. Methods for definition of the field variables. Eulerian and Lagrangian points of view. Continuity equation in Eulerian and Lagrangian forms and their derivation.
- Advection transport term. Continuity equation for an incompressible fluid.
- Exercise: Computing divergence of velocity field.

#### Week 2: Density and gravity
- Exercise: Computing density, thermal expansion and compressibility from an equation of state.

#### Week 3: Stress and strain
- Exercise: Analysing strain rate tensor for solid body rotation.

#### Week 4: The momentum equation
- Exercises: Computing velocity for magma flow in a channel.

#### Week 5: Viscous rheology of rocks
- Theory: Solid-state creep of minerals and rocks as the major mechanism of deformation of the Earth's interior. Dislocation and diffusion creep mechanisms. Rheological equations for minerals and rocks. Effective viscosity and its dependence on temperature, pressure and strain rate. Formulation of the effective viscosity from empirical flow laws.
- Exercise: Deriving viscous rheological equations for computing effective viscosities from empirical flow laws.

#### Week 6: The heat conservation equation
- Exercise: Steady temperature profile in case of channel flow.

#### Week 7: Elasticity and plasticity

### Lecture notes
- Script is available by request to taras.gerya@erdw.ethz.ch
- Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS

### Literature
- Taras Gerya Introduction to Numerical Geodynamic Modelling Cambridge University Press, 2010

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### Geophysics: Subject 2

#### Number Title Type ECTS Hours Lecturers

651-4241-00L Numerical Modelling I and II: Theory and Applications W 6 credits 4G T. Gerya

**Abstract**

In this 13-week sequence, students learn how to write programs from scratch to solve partial differential equations that are useful for Earth science applications. Programming will be done in MATLAB and will use the finite-difference method and marker-in-cell technique. The course will emphasise a hands-on learning approach rather than extensive theory.

**Objective**

The goal of this course is for students to learn how to program numerical applications from scratch. By the end of the course, students should be able to write state-of-the-art MATLAB codes that solve systems of partial-differential equations relevant to Earth and Planetary Science applications using finite-difference method and marker-in-cell technique. Applications include Poisson equation, buoyancy driven variable viscosity flow, heat diffusion and advection, and state-of-the-art thermomechanical code programming. The emphasis will be on commonality, i.e., using a similar approach to solve different applications, and modularity, i.e., re-use of code in different programs. The course will emphasise a hands-on learning approach rather than extensive theory, and will begin with an introduction to programming in MATLAB.
Content

A provisional week-by-week schedule (subject to change) is as follows:

Week 1: Introduction to the finite difference approximation to differential equations. Introduction to programming in Matlab. Solving of 1D Poisson equation.
Week 3: Solving momentum and continuity equations in case of constant viscosity with stream function/vorticity formulation.
Weeks 5: Conservative finite differences for the momentum equation. "Free slip" and "no slip" boundary conditions. Solving momentum and continuity equations in case of variable viscosity using pressure-velocity formulation with staggered grid.
Week 7: Advection in 2-D with Marker-in-cell method. Combining flow calculation and advection for buoyancy driven flow.
Week 8: "Free surface" boundary condition and "sticky air" approach. Free surface stabilization. Runge-Kutta schemes.
Week 9: Solving 2D heat conservation equation in case of constant thermal conductivity with explicit and implicit approaches.
Week 10: Solving 2D heat conservation equation in case of variable thermal conductivity with implicit approach. Temperature advection with markers. Creating thermomechanical code by combining mechanical solution for 2D buoyancy driven flow with heat diffusion and advection based on marker-in-cell approach.
Week 11: Subgrid diffusion of temperature. Implementing subgrid diffusion to the thermomechanical code.
Week 12: Implementation of radioactive, adiabatic and shear heating to the thermomechanical code.
Week 13: Implementation of temperature-, pressure- and strain rate-dependent viscosity, temperature- and pressure-dependent density and temperature-dependent thermal conductivity to the thermomechanical code. Final project description.

GRADING will be based on weekly programming homeworks (50%) and a term project (50%) to develop an application of their choice to a more advanced level.

Literature
Taras Gerya, Introduction to Numerical Geodynamic Modelling, Cambridge University Press 2010

Geophysics: Subject 3
Offered in the spring semester

Geophysics: Subject 4
Offered in the spring semester

Geophysics: Subject 5

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4014-00L</td>
<td>Seismic Tomography</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>E. Kissling, T. Diehl</td>
</tr>
</tbody>
</table>

Seismic tomography is the science of interpreting seismic measurements (seismograms) to derive information about the structure of the Earth. The subject of this course is the formal relationship existing between a seismic measurement and the nature of the Earth, or of certain regions of the Earth, and the ways to use it, to gain information about the Earth.

Literature

Geophysics: Subject 6
Offered in the spring semester

Geophysics: Subject 6

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>636-0007-00L</td>
<td>Computational Systems Biology</td>
<td>W</td>
<td>6</td>
<td>3+2U</td>
<td>J. Stelling</td>
</tr>
</tbody>
</table>

Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content
Biology has witnessed a tremendous increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Lecture notes
https://www.ethz.ch/content/specialinterest/bsse/computational-systems-biology/en/education/lectures/csb/LectureMaterial.html

Abstract

This course focuses on modeling spatio-temporal problems in biology, in particular on the cell and tissue level. A wide range of mathematical techniques will be presented as part of the course, including concepts from non-linear dynamics (ODE and PDE models), stochastic techniques (SDE, Master equations, Monte Carlo simulations), and thermodynamic descriptions.

Objective

The aim of the course is to introduce students to state-of-the-art mathematical modelling of spatio-temporal problems in biology. Students will learn how to choose from a wide range of modelling techniques and how to apply these to further our understanding of biological mechanisms. The course aims at equipping students with the tools and concepts to conduct successful research in this area; both classical as well as recent research work will be discussed.

Content

1. Introduction to Modelling in Biology
2. Morphogen Gradients
3. Turing Pattern
4. Travelling Waves & Wave Pinning
5. Application Example 1: Dorso-ventral axis formation
6. Chemotaxis, Cell Adhesion & Migration
7. Introduction to Numerical Methods
8. Simulations on Growing Domains
9. Image-Based Modelling
10. Branching Processes
11. Cell-based Simulation Frameworks
12. Application Example 2: Limb Development
13. Summary

Lecture notes

All lecture material will be made available online
https://www.bsse.ethz.ch/cobi/education/636-0706-00L_Spatial_Modelling_in_Biology.html

Literature

Murray, Mathematical Biology, Springer
Forgacs and Newman, Biological Physics of the Developing Embryo, CUP
Keener and Sneyd, Mathematical Physiology, Springer
Fall et al, Computational Cell Biology, Springer
Szallasi et al, System Modeling in Cellular Biology, MIT Press
Wolkenhauer, Systems Biology
Kreyzig, Engineering Mathematics, Wiley

Prerequisites / notice

The course builds on introductory courses in Computational Biology. The course assumes no background in biology but a good foundation regarding mathematical and computational techniques.

Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0113-00L</td>
<td>Applied Fluid Dynamics</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>J.P. Kunsch</td>
</tr>
<tr>
<td></td>
<td>Applied Fluid Dynamics</td>
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</tr>
<tr>
<td>Abstract</td>
<td>The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment.</td>
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<tr>
<td>Objective</td>
<td>Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples.</td>
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<tr>
<td>Content</td>
<td>Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Requirements: successful attendance at lectures &quot;Fluidodynamik I und II&quot;, &quot;Thermodynamik I und II&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>not available</td>
<td></td>
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<tr>
<td>151-0709-00L</td>
<td>Stochastic Methods for Engineers and Natural Scientists</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>D. W. Meyer-Massetti, N. Noiray</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides an introduction into stochastic methods that are applicable for example for the description and modeling of turbulent and subsurface flows. Moreover, mathematical techniques are presented that are used to quantify uncertainty in various engineering applications.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>By the end of the course you should be able to mathematically describe random quantities and their effect on physical systems. Moreover, you should be able to develop basic stochastic models of such systems.</td>
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</tr>
</tbody>
</table>
| Content      | - Probability theory, single and multiple random variables, mappings of random variables  
- Stochastic differential equations, Ito calculus, PDF evolution equations  
- Polynomial chaos and other expansion methods  
All topics are illustrated with application examples from engineering. |      |      |       |                            |
| Lecture notes| Detailed lecture notes will be provided. |      |      |       |                            |
| 151-0317-00L | Visualization, Simulation and Interaction - Virtual Reality II | W    | 4    | 3G    | A. Kunz                    |
| Abstract     | This lecture provides deeper knowledge on the possible applications of virtual reality, its basic technology, and future research fields. The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes. |      |      |       |                            |
| Objective    | Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems. The goal of the lecture is to provide a deeper knowledge of today’s VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given. |      |      |       |                            |
| Content      | Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of simulation; compression procedures of image-, audio-, and video signals; new materials for force feedback devices; introduction into data security; cryptography; definition of free-form surfaces; digital factory; new research fields of virtual reality |      |      |       |                            |
Prerequisites / notice
Prerequisites:
"Visualization, Simulation and Interaction - Virtual Reality I" is recommended.

Didactical concept:
The course consists of lectures and exercises.

Principles of Nonlinear Finite-Element-Methods

Abstract
Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.

Objective
The goal of the lecture is to provide the students with the fundamentals of the nonlinear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite Element Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite Element Methods are simulations of:
- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Content
- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

Lecture notes
yes

Literature

If we will have a large number of students, two dates for the exercises will be offered.
### Literature


### Prerequisites / notice

**263-3010-00L Big Data**

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>2V+2U+1A</th>
<th>G. Fourny</th>
</tr>
</thead>
</table>

**Abstract**
The key challenge of the information society is to turn data into information, information into knowledge, knowledge into value. This has become increasingly complex. Data comes in larger volumes, diverse shapes, from different sources. Data is more heterogeneous and less structured than forty years ago. Nevertheless, it still needs to be processed fast, with support for complex operations.

**Objective**
This combination of requirements, together with the technologies that have emerged in order to address them, is typically referred to as "Big Data." This revolution has led to a completely new way to do business, e.g., develop new products and business models, but also to do science -- which is sometimes referred to as data-driven science or the "fourth paradigm".

Unfortunately, the quantity of data produced and available -- now in the Zettabyte range (that’s 21 zeros) per year -- keeps growing faster than our ability to process it. Hence, new architectures and approaches for processing it were and are still needed. Harnessing them must involve a deep understanding of data not only in the large, but also in the small.

The field of databases evolves at a fast pace. In order to be prepared, to the extent possible, to the (r)evolutions that will take place in the next few decades, the emphasis of the lecture will be on the paradigms and core design ideas, while today's technologies will serve as supporting illustrations thereof.

After visiting this lecture, you should have gained an overview and understanding of the Big Data landscape, which is the basis on which one can make informed decisions, i.e., pick and orchestrate the relevant technologies together for addressing each business use case efficiently and consistently.

**Content**
This course gives an overview of database technologies and of the most important database design principles that lay the foundations of the Big Data universe. The material is organized along three axes: data in the large, data in the small, data in the very small. A broad range of aspects is covered with a focus on how they fit all together in the big picture of the Big Data ecosystem.

- Physical storage (HDFS, S3)
- Logical storage (key-value stores, document stores, column stores, key-value stores, data warehouses)
- Data formats and syntaxes (XML, JSON, CSV, ABRAL)
- Data shapes and models (tables, trees, graphs, cubes)
- Overview of programming languages with a focus on their type systems (SQL, XQuery, MDX)
- The most important query paradigms (selection, projection, joining, grouping, ordering, windowing)
- Paradigms for parallel processing (MapReduce) and technologies (Hadoop, Spark)
- Optimization techniques (functional and declarative paradigms, query plans, rewrites, indexing)
- Applications.

We will also host two guest lectures to get insights from the industry: UBS and Google.

**Literature**
Large scale analytics and machine learning are outside of the scope of this course.

Papers from scientific conferences and journals. References will be given as part of the course material during the semester.

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**263-5200-00L Data Mining: Learning from Large Data Sets**

<table>
<thead>
<tr>
<th>W</th>
<th>4 credits</th>
<th>2V+1U</th>
<th>A. Krause</th>
</tr>
</thead>
</table>

**Abstract**
Many scientific and commercial applications require insights from massive, high-dimensional data sets. This course introduces principal state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course both covers theoretical foundations and practical applications.

**Objective**
Many scientific and commercial applications require us to obtain insights from massive, high-dimensional data sets. In this graduate-level course, we will study principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course will both cover theoretical foundations and practical applications.

**Content**
Topics covered:
- Dealing with large data (Data centers; Map-Reduce/Hadoop; Amazon Mechanical Turk)
- Fast nearest neighbor methods (Shingling, locality sensitive hashing)
- Online learning (Online optimization and regret minimization, online convex programming, applications to large-scale Support Vector Machines)
- Multi-armed bandits (exploration-exploitation tradeoffs, applications to online advertising and relevance feedback)
- Active learning (uncertainty sampling, pool-based methods, label complexity)
- Dimension reduction (random projections, nonlinear methods)
- Data streams (Sketches, coresets, applications to online clustering)
- Recommender systems

**Prerequisites / notice**
Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.

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**263-2800-00L Design of Parallel and High-Performance Computing**

<table>
<thead>
<tr>
<th>W</th>
<th>7 credits</th>
<th>3V+2U+1A</th>
<th>T. Hoefer, M. Püschel</th>
</tr>
</thead>
</table>

**Abstract**
Advanced topics in parallel / concurrent programming.

**Objective**
Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.

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**263-3210-00L Deep Learning**

<table>
<thead>
<tr>
<th>W</th>
<th>4 credits</th>
<th>2V+1U</th>
<th>T. Hofmann</th>
</tr>
</thead>
</table>

**Abstract**
Deep learning is an area within machine learning that deals with algorithms and models that automatically induce multi-level data representations.

**Objective**
In recent years, deep learning and deep networks have significantly improved the state-of-the-art in many application domains such as computer vision, speech recognition, and natural language processing. This class will cover the fundamentals of deep learning and provide a rich set of hands-on tasks and practical projects to familiarize students with this emerging technology.

**Prerequisites / notice**
The participation in the course is subject to the following conditions:
1. The number of participants is limited to 120 students (MSc and PhDs).
2. Students must have taken the exam in Machine Learning (252-0535-00) or have acquired equivalent knowledge.
Discrete Event Systems

Abstract
Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

Objective
Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.

Content
1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

Lecture notes
Available

Literature
[bertsekas] Data Networks
Dimitri Bertsekas, Robert Gallager

[borodin] Online Computation and Competitive Analysis
Allan Borodin, Ran El-Yaniv,
Cambridge University Press, 1998

[boudec] Network Calculus
J.-Y. Le Boudec, P. Thiran
Springer, 2001

[cassandras] Introduction to Discrete Event Systems
Christos Cassandras, Stéphane Lafortune.

[fiat] Online Algorithms: The State of the Art
A. Fiat and G. Woeginger

D. Hochbaum

[schickinger] Diskrete Strukturen (Band 2: Wahrscheinlichkeitstheorie und Statistik)
T. Schickinger, A. Steger
Springer, Berlin, 2001

[sipser] Introduction to the Theory of Computation
Michael Sipser,

Wearable Systems I

Abstract
Context recognition in mobile communication systems like mobile phone, smart watches and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning. Context comprises the behavior of individuals and of groups, their activities as well as the local and social environment.

Objective
Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our 'smart phone' detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our 'smart phone' offers us the appropriate services like a personal assistant. Context comprises user's behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone. Context recognition as the crucial function of mobile systems is the main focus of the course. Using MatLab the participants implement and verify the discussed methods also using a smart phone.
The entropy rate of a source, typical sequences, the asymptotic equi-partition property, the source coding theorem, Huffman coding.

A. Lapidoth

This course covers the basic concepts of information theory and of communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.

T.M. Cover and J. Thomas, Elements of Information Theory (second edition)

The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that we see as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

The main topics of the course include:

- Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarity measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, KNN-Methods, Support Vector Machine, Adaboost, Deep Learning), clustering (k-means, dbscan, topic models), Recommender Systems, Collaborative Filtering, Crowdsourcing.

The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

Language: german/english (depending on the participants)

Literature:

- Lecture notes for all lessons, assignments and solutions.
- http://www.ife.ee.ethz.ch/education/wearable_systems_1

Prerequisites:

- local bachelor's course "Discrete-Time and Statistical Signal Processing" (5. Sem.)
- others: solid basics in linear algebra and probability theory

Lecture notes:

- Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites:

- Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.

The course language is English.
Content
The lecture "Applied Computer Architecture" gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits.
Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)?
Which architecture is behind the alarm center of the Swiss Railway (SBB)?
Which computer architectures are applied for driver assistance systems?
Which computer architecture is hidden behind a professional digital audio mixing desk?
How can data streams of about 30 TB/s, produced by a proton accelerator, be processed in real time?
Can the weather forecast also be processed with GPUs?
How can a good computer architecture be found?
Which are the driving factors in successful computer architecture design?

Lecture notes
Script and exercises sheets.

Prerequisites / notice
Basics of computer architecture.

252-0237-00L
Concepts of Object-Oriented Programming
W
6 credits
3V+2U
P. Müller

Abstract
Course that focuses on an in-depth understanding of object-oriented programming and compares designs of object-oriented programming languages. Topics include different flavors of type systems, inheritance models, encapsulation in the presence of aliasing, object and class initialization, program correctness, reflection.

Objective
After this course, students will:
Have a deep understanding of advanced concepts of object-oriented programming and their support through various language features.
Be able to understand language concepts on a semantic level and be able to compare and evaluate language designs.
Be able to learn new languages more rapidly.
Be aware of many subtle problems of object-oriented programming and know how to avoid them.

Content
The main goal of this course is to convey a deep understanding of the key concepts of sequential object-oriented programming and their support in different programming languages. This is achieved by studying how important challenges are addressed through language features and programming idioms. In particular, the course discusses alternative language designs by contrasting solutions in languages such as C++, C#, Eiffel, Java, Python, and Scala. The course also introduces novel ideas from research languages that may influence the design of future mainstream languages.

The topics discussed in the course include among others:
The pros and cons of different flavors of type systems (for instance, static vs. dynamic typing, nominal vs. structural, syntactic vs. behavioral typing)
The key problems of single and multiple inheritance and how different languages address them
Generic type systems, in particular, Java generics, C# generics, and C++ templates
The situations in which object-oriented programming does not provide encapsulation, and how to avoid them
The pitfalls of object initialization, exemplified by a research type system that prevents null pointer dereferencing
How to maintain the consistency of data structures

Literature
Will be announced in the lecture.

Prerequisites / notice
Prerequisites:
Mastering at least one object-oriented programming language (this course will NOT provide an introduction to object-oriented programming); programming experience.

252-0417-00L
Randomized Algorithms and Probabilistic Methods
W
7 credits
3V+2U+1A
A. Steger, E. Welzl

Abstract
Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains; convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks.

Objective
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Content
Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Literature
Yes.

252-0546-00L
Physically-Based Simulation in Computer Graphics
W
4 credits
2V+1U
B. Solenthaler, B. Thomaszewski

Abstract
This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.

Objective
This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.

Content
The lecture covers topics in physically-based modeling, such as particle systems, mass-spring models, finite difference and finite element methods. These approaches are used to represent and simulate deformable objects or fluids with applications in animated movies, 3D games and medical systems. Furthermore, the lecture covers topics such as rigid body dynamics, collision detection, and character animation.

Prerequisites / notice
Fundamentals of calculus and physics, basic concepts of algorithms and data structures, basic programming skills in C++; Knowledge on numerical mathematics as well as ordinary and partial differential equations is an asset, but not required.

401-3611-00L
Advanced Topics in Computational Statistics
W
4 credits
2V
M. H. Maathuis

Abstract
This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.

Objective
Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

Content
The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

Lecture notes
Lecture notes.

Prerequisites / notice
We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

401-3627-00L
High-Dimensional Statistics
W
4 credits
2V
P. L. Bühlmann

Abstract
"High-Dimensional Statistics" deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.
<table>
<thead>
<tr>
<th>Objective</th>
<th>Content</th>
<th>Literature</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of methods and basic theory for high-dimensional statistical inference.</td>
<td>Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling</td>
<td>Peter Bühlmann and Sara van de Geer (2011). Statistics for High-Dimensional Data: Methods, Theory and Applications. Springer Verlag. ISBN 978-3-642-20191-2.</td>
<td>Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>401-4623-00L</th>
<th>Time Series Analysis</th>
<th>W</th>
<th>6 credits</th>
<th>3G</th>
<th>N. Meinshausen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.</td>
<td>Content</td>
<td>This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Not available</td>
<td>Literature</td>
<td>A list of references will be distributed during the course.</td>
<td>Prerequisites / notice</td>
<td>Basic knowledge in probability and statistics</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>401-3901-00L</th>
<th>Mathematical Optimization</th>
<th>W</th>
<th>11 credits</th>
<th>4V+2U</th>
<th>R. Weismantel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Advanced optimization theory and algorithms.</td>
<td>Content</td>
<td>1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas' Lemma and infeasibility certificates, duality theory of linear programming.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 6.</td>
<td>Prerequisites</td>
<td>3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prerequisites: Completed courses</td>
<td></td>
<td>4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>401-3640-60L</th>
<th>Monte Carlo and Quasi-Monte Carlo Methods: Mathematical and Numerical Analysis</th>
<th>W</th>
<th>4 credits</th>
<th>2S</th>
<th>C. Schwab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Number of participants limited to 6.</td>
<td>Content</td>
<td>Introduction and current research topics in the theory and implementation of Monte Carlo and quasi-Monte Carlo methods and applications.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Completed courses</td>
<td>Literature</td>
<td>Numerical Analysis of Elliptic/Parabolic PDEs, or Numerical Analysis of Hyperbolic PDEs, or Numerical Analysis of Stochastic ODEs, and FAI, Probability Theory I.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>402-0777-00L</th>
<th>Particle Accelerator Physics and Modeling I</th>
<th>W</th>
<th>6 credits</th>
<th>2V+1U</th>
<th>A. Adelmann</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>You understand the building blocks of particle accelerators. Modern analysis tools allows you to model state-of-the-art particle accelerators. In some of the exercises you will be confronted with next generation machines. We will develop a Python simulation tool (AcceLEGrator) that reflects the theory from the lecture.</td>
<td>Content</td>
<td>Here is the rough plan of the topics, however the actual pace may vary relative to this plan.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>227-1033-00L</th>
<th>Neurorphic Engineering I</th>
<th>W</th>
<th>6 credits</th>
<th>2V+3U</th>
<th>T. Delbrück, G. Indiveri, S.C. Liu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration in this class requires the permission of the instructors. Class size will be limited to available lab spots. Preference is given to students that require this class as part of their major.</td>
<td>Abstract</td>
<td>This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.</td>
<td>Objective</td>
<td>Understanding of the characteristics of neuromorphic circuit elements.</td>
<td></td>
</tr>
</tbody>
</table>
Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. This property leads to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

Literature
- S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

Prerequisites / notice
- Particular: The course is highly recommended for those who intend to take the spring semester course ‘Neuromorphic Engineering II’, that teaches the conception, simulation, and physical layout of such circuits with chip design tools.
Prerequisites / notice

see also Fields of Specialization

► Case Studies

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3667-66L</td>
<td>Case Studies Seminar (Autumn Semester 2016)</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>V. C. Gradinaru, R. Hiptmair, M. Reiher</td>
</tr>
</tbody>
</table>

Abstract
In the CSE Case Studies Seminar invited speakers from ETH, from other universities as well as from industry give a talk on an applied topic. Beside of attending the scientific talks students are asked to give short presentations (10 minutes) on a published paper out of a list.

► Semester Paper

There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3740-01L</td>
<td>Semester Paper ▲</td>
<td>W</td>
<td>8 credits</td>
<td>11A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
Semester Papers help to deepen the students’ knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students’ ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice
There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3740-02L</td>
<td>Semester Paper ▲</td>
<td>W</td>
<td>8 credits</td>
<td>11A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
Semester Papers help to deepen the students’ knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students’ ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice
There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

► GESS Science in Perspective

see Science in Perspective: Type A: Enhancement of Reflection Capability

see Science in Perspective: Language Courses ETH/UZH

Recommended Science in Perspective (Type B) for D-MATH.

► Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2000-00L</td>
<td>Scientific Works in Mathematics</td>
<td>O</td>
<td>0 credits</td>
<td></td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

Target audience:
Third year Bachelor students;
Master students who cannot document to have received an adequate training in working scientifically.

Mandatory for all Bachelor and Master students with matriculation in the autumn semester 2014 or later.


Abstract
Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)

Objective
Learn the basic standards of scientific works in mathematics.

- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519

Prerequisites / notice
This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-4990-01L</td>
<td>Master's Thesis ▲</td>
<td>O</td>
<td>30 credits</td>
<td>57D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfil the following criteria are allowed to begin with their master's thesis:
a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to
gain admission to the master programme.
For Programme Regulations 2014 there are additional
requirements.

No direct enrolment to this course unit in myStudies.
Please fill in the online application form.
Requirements and application form under
www.math.ethz.ch/intranet/students/study-
administration/theses.html
(Afterwards the enrolment will be done by the Study
Administration.)

Abstract
The master’s thesis concludes the study programme. Thesis work should prove the students’ ability to independent, structured and
scientific working.

Objective
Thesis work should prove the students’ ability to independent, structured and scientific working.

Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Course Units for Additional Admission Requirements
The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0122-AAL</td>
<td>Fluid Dynamics for CSE</td>
<td>E-</td>
<td>5</td>
<td>11R</td>
<td>T. Rösgen</td>
</tr>
</tbody>
</table>

Abstract
An introduction to the physical and mathematical foundations of fluid dynamics is given.
Topics include dimensional analysis, integral and differential conservation laws, inviscid and viscous flows, Navier-Stokes equations,
boundary layers, turbulent pipe flow. Elementary solutions and examples are presented.

Objective
An introduction to the physical and mathematical principles of fluid dynamics. Fundamental terminology/principles and their application to
simple problems.

Content
Phänomene, Anwendungen, Grundfragen
Dimensionsanalyse und Ähnlichkeit; Kinematische Beschreibung; Erhaltungssätze (Masse, Impuls, Energie), integrale und differentielle
Formulierungen; Reibungsfreie Strömungen: Euler-Gleichungen, Stromfadentheorie, Satz von Bernoulli; Reibungsbehaftete Strömungen:
Navier-Stokes-Gleichungen; Grenzschichten; Turbulenz

Lecture notes
Eine erweiterte Formelsammlung zur Vorlesung wird elektronisch zur Verfügung gestellt.

Literature
Empfohlenes Buch: Fluid Mechanics, P. Kundu & I. Cohen, Elsevier

Prerequisites / notice
Performance Assessment: session examination
Allowed aids: Textbook (free selection, list of assignments), list of formulars IFD, 8 Sheets (=4 Pages) own notes, calculator

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0353-AAL</td>
<td>Analysis III</td>
<td>E-</td>
<td>4</td>
<td>9R</td>
<td>M. Soner</td>
</tr>
</tbody>
</table>

Abstract
Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic,
parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier
series, separation of variables, methods of characteristics.

Objective
Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential
equations.
Laplace Transforms:
- Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
- Transforms of Derivatives and Integrals, ODEs
- Unit Step Function, t-Shifting
- Short Impulses, Dirac's Delta Function, Partial Fractions
- Convolution, Integral Equations
- Differentiation and Integration of Transforms

Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:
- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates: Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:
- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates: Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

Literature

For reference/complement of the Analysis I/II courses:
Christian Blatter: Ingenieur-Analysis (Download PDF)

Prerequisites / notice
Up-to-date information about this course can be found at:
http://www.math.ethz.ch/education/bachelor/lectures/hs2013/other/analysis3_itet

406-0603-AAL Stochastics (Probability and Statistics) E- 4 credits 9R M. Kalisch
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content
From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student's t Distribution
Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

Literature
- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
From within the ETH, this book is freely available online under:

From within the ETH, this book is freely available online under:
http://www.springerlink.com/content/m17578/

406-0663-AAL Numerical Methods for CSE E- 7 credits 15R R. Hiptmair
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.
Abstract

The course gives an introduction into fundamental techniques and algorithms of numerical mathematics which play a central role in numerical simulations in science and technology. The course focuses on fundamental ideas and algorithmic aspects of numerical methods. The exercises involve actual implementation of numerical methods in C++.

Objective

* Knowledge of the fundamental algorithms in numerical mathematics
* Knowledge of the essential terms in numerical mathematics and the techniques used for the analysis of numerical algorithms
* Ability to choose the appropriate numerical method for concrete problems
* Ability to interpret numerical results
* Ability to implement numerical algorithms efficiently

Content

1. Direct Methods for linear systems of equations
2. Least Squares Techniques
3. Data Interpolation and Fitting
4. Filtering Algorithms
5. Approximation of Functions
6. Numerical Quadrature
7. Iterative Methods for non-linear systems of equations
8. Single Step Methods for ODEs
9. Stiff Integrators

Lecture notes

Lecture materials (PDF documents and codes) will be made available to participants.

Literature

M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002
P. Deuflhard and A. Hohmann, "Numerische Mathematik I", DeGruyter, 2002

Prerequisites / notice

Solid knowledge about fundamental concepts and techniques from linear algebra & calculus as taught in the first year of science and engineering curricula.

The course will be accompanied by programming exercises in C++ relying on the template library EIGEN. Familiarity with C++, object oriented and generic programming is an advantage. Participants of the course are expected to learn C++ by themselves.

---

Abstract

The course Software Design presents and discusses design patterns regularly used to solve problems in object oriented design and object oriented programming. The presented patterns are illustrated with examples from the Java libraries and are applied in a project.

Objective

The students
- know the principles of object oriented programming and can apply these.
- know the most important object oriented design patterns.
- can apply design patterns to solve design problems.
- discover in a given design the use of design patterns.

---

Abstract

Principles and applications of statistical mechanics and equilibrium molecular dynamics, Monte Carlo simulation, Stochastic dynamics. Exercises using a MD simulation program to generate ensembles and subsequently calculate ensemble averages.

Objective

Introduction to statistical mechanics with the aid of computer simulation, development of skills to carry out statistical mechanical calculations using computers and interpret the results.

Content

Principles and applications of statistical mechanics and equilibrium molecular dynamics, Monte Carlo simulation, Stochastic dynamics. Exercises using a MD simulation program to generate ensembles and subsequently calculate ensemble averages.

Lecture notes

available

Literature

see "Course Schedule"

additional information will be provided in the first lecture.

---

Computational Science and Engineering Master - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Koumoutsakos</td>
</tr>
<tr>
<td></td>
<td><em>Number of participants limited to 60.</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Objective</td>
<td>The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.</td>
<td></td>
<td></td>
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<tr>
<td>Content</td>
<td>Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.</td>
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<tr>
<td>Lecture notes</td>
<td>The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.</td>
<td></td>
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</tr>
</tbody>
</table>
| Literature | 1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia  
2. Probability Theory: The Logic of Science by E. T. Jaynes  
3. Class Notes |
| Prerequisites / notice | Fundamentals of Probability, Fundamentals of Computational Modeling |

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0107-20L</td>
<td>High Performance Computing for Science and Engineering (HPCSE) I</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>M. Troyer, P. Chatzidoukas</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.</td>
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</tbody>
</table>
| Objective  | Introduction to HPC for scientists and engineers  
Fundamental of:  
1. Parallel Computing Architectures  
2. MultiCores  
3. ManyCores |
| Content    | Programming models and languages:  
1. C++ threading (2 weeks)  
2. OpenMP (4 weeks)  
3. MPI (5 weeks)  
Computers and methods:  
1. Hardware and architectures  
2. Libraries  
3. Particles: N-body solvers  
4. Fields: PDEs  
5. Stochastics: Monte Carlo |
| Lecture notes | http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1  
Class notes, handouts |

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0509-00L</td>
<td>Microscale Acoustofluidics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Dual</td>
</tr>
<tr>
<td>Abstract</td>
<td>In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Understanding acoustophoresis, the design of devices and potential applications</td>
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<tr>
<td>Content</td>
<td>Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microrobotics to surface acoustic wave devices</td>
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<tr>
<td>Literature</td>
<td>Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.</td>
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</table>

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0563-01L</td>
<td>Dynamic Programming and Optimal Control</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>R. D’Andrea</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to Dynamic Programming and Optimal Control.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Covers the fundamental concepts of Dynamic Programming &amp; Optimal Control.</td>
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</tr>
<tr>
<td>Content</td>
<td>Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.</td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0593-00L</td>
<td>Embedded Control Systems</td>
<td>W</td>
<td>4</td>
<td>6G</td>
<td>J. S. Freudenberg, C. Onder</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Familiarize students with main architectural principles and concepts of embedded control systems.</td>
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</tbody>
</table>
An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch.

Subjects covered in lectures and practical lab exercises include:
- The application of C-programming on a microprocessor
- Digital I/O and serial communication
- Quadrature decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Pulse width modulation
- Timer interrupts to create sampling time intervals
- System dynamics and virtual worlds with haptic feedback
- Introduction to rapid prototyping

The lecture will be taught in English.

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: marischm@ethz.ch) After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

Detailed information can be found on the course website http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html

### 151-0601-00L Theory of Robotics and Mechatronics

<table>
<thead>
<tr>
<th></th>
<th>Theory of Robotics and Mechatronics</th>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>P. Korba, S. Stoeter, B. Nelson</th>
</tr>
</thead>
</table>

Abstract
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

Objective
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Content
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

The course will be taught in English.

### 151-0604-00L Microrobotics

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<thead>
<tr>
<th></th>
<th>Microrobotics</th>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>B. Nelson</th>
</tr>
</thead>
</table>

Abstract
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

Objective
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Content
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

The course will be taught in English.

### 151-0623-00L ETH Zurich Distinguished Seminar in Robotics, Systems and Controls

<table>
<thead>
<tr>
<th></th>
<th>ETH Zurich Distinguished Seminar in Robotics, Systems and Controls</th>
<th>W</th>
<th>1 credit</th>
<th>1S</th>
<th>B. Nelson, J. Buchli, M. Chli, R. Gassert, M. Hutter, W. Karlen, R. Riener, R. Siegwart</th>
</tr>
</thead>
</table>

Abstract
Students for other Master's programmes in Department Mechanical and Process Engineering cannot use the credit in the category Core Courses

Objective
Obtain an overview of various topics in Robotics, Systems, and Controls from leaders in the field. Please see http://www.msrl.ethz.ch/education/distinguished-seminar-in-robotics--systems--controls--151-0623-0.html for a list of upcoming lectures.

Content
This course consists of a series of seven lectures given by researchers who have distinguished themselves in the area of Robotics, Systems, and Controls. MSc students in Robotics, Systems, and Controls are required to attend every lecture. Attendance will be monitored. If for some reason a student cannot attend one of the lectures, the student must select another ETH or University of Zurich seminar related to the field and submit a one page description of the seminar topic. Please see http://www.msrl.ethz.ch/education/distinguished-seminar-in-robotics--systems--controls--151-0623-0.html for a suggestion of other lectures.

The lecture will be taught in English.

### 151-0632-00L Vision Algorithms for Mobile Robotics

<table>
<thead>
<tr>
<th></th>
<th>Vision Algorithms for Mobile Robotics</th>
<th>W</th>
<th>4 credits</th>
<th>2V+2U</th>
<th>D. Scaramuzza</th>
</tr>
</thead>
</table>

Abstract
For a robot to be autonomous, it has to perceive and understand the world around it. This course introduces you to the fundamental computer vision algorithms used in mobile robotics, in particular: feature extraction, multiple view geometry, dense reconstruction, object tracking, image retrieval, event-based vision, and visual-inertial odometry (the algorithm behind Google Tango).

Objective
Learn the fundamental computer vision algorithms used in mobile robotics, in particular: feature extraction, multiple view geometry, dense reconstruction, object tracking, image retrieval, event-based vision, and visual-inertial odometry (the algorithm behind Google Tango).
### 151-0851-00L

**Abstract**
We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

**Objective**
The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

**Content**
The course consists of three parts: First, we will refresh and deepen the student’s knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

**Prerequisites / notice**
The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Basics in Fluid Dynamics.

### 151-1116-00L

**Abstract**
Introduction to Aircraft and Car Aerodynamics. To understand the basic relations of the origin of aerodynamic forces (ie lift, drag). To quantify the aerodynamic forces for basic configurations of aircraft and car components. Illustration of the intrinsic problems and results using examples. Using experimental and theoretical methods to illustrate possibilities and limits.

**Objective**
An introduction to the basic principles and interrelationships of aircraft and automotive aerodynamics. To understand the basic relations of the origin of aerodynamic forces (ie lift, drag). To quantify the aerodynamic forces for basic configurations of aircraft and car components. Illustration of the intrinsic problems and results using examples.

**Content**

**Literature**

**Prerequisites / notice**
The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Basics in Fluid Dynamics.

### 151-0532-00L

**Abstract**
Nonlinear Dynamics and Chaos I. Basic facts about nonlinear systems; stability and near-equilibrium dynamics; bifurcations; dynamical systems on the plane; non-autonomous dynamical systems; chaotic dynamics.

**Objective**
This course is intended for Masters and Ph.D. students in engineering sciences, physics and applied mathematics who are interested in the behavior of nonlinear dynamical systems. It offers an introduction to the qualitative study of nonlinear physical phenomena modeled by differential equations or discrete maps. We discuss applications in classical mechanics, electrical engineering, fluid mechanics, and biology. A more advanced Part II of this class is offered every other year.

**Content**
1. Basic facts about nonlinear systems: Existence, uniqueness, and dependence on initial data.
3. Bifurcations of equilibria: Center manifolds, normal forms, and elementary bifurcations.
4. Nonlinear dynamical systems on the plane: Phase plane techniques, limit sets, and limit cycles.
5. Time-dependent dynamical systems: Floquet theory, Poincare maps, averaging methods, resonance.

**Lecture notes**
The class lecture notes will be posted electronically after each lecture. Students should not rely on these but prepare their own notes during the lecture.

**Prerequisites / notice**
- Prerequisites: Analysis, linear algebra and a basic course in differential equations.
- Exam: two-hour written exam in English.
- Home assignment: A homework assignment will be due roughly every other week. Hints to solutions will be posted after the homework due dates.

### 227-0102-00L

**Abstract**
Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.
Objective

Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g., hitting a keyboard key, sending a message), some not (e.g., spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.

Content

1. Introduction
2. Automata and Languages
3. Smarteer Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

Lecture notes

Available

Literature

[bertsekas] Data Networks
Dimitri Bertsekas, Robert Gallager

[borodin] Online Computation and Competitive Analysis
Allan Borodin, Ran El-Yaniv.
Cambridge University Press, 1998

[boudec] Network Calculus
J.-Y. Le Boudec, P. Thiran
Springer, 2001

[cassandras] Introduction to Discrete Event Systems
Christos Cassandras, Stéphane Lafortune.

[fiat] Online Algorithms: The State of the Art
A. Fiat and G. Woeginger

D. Hochbaum

[schickinger] Diskrete Strukturen (Band 2: Wahrscheinlichkeitstheorie und Statistik)
T. Schickinger, A. Steger
Springer, Berlin, 2001

[sipser] Introduction to the Theory of Computation
Michael Sipser.

227-0103-00L Control Systems W 6 credits 2V+2U F. Dörfler

Abstract
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Objective
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Content

Literature

Prerequisites / notice
Prerequisites: Signal and Systems Theory II.
MATLAB is used for system analysis and simulation.

227-0225-00L Linear System Theory W 6 credits 5G M. Kamgarpour

Abstract
The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.

Objective
By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.

Content
- Rings, fields and linear spaces, normed linear spaces and inner product spaces.
- Ordinary differential equations, existence and uniqueness of solutions.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Stability and stabilization, observers, state and output feedback, separation principle.
- Realization theory.

Lecture notes

Prerequisites / notice

Lecture notes

Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites:

Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.

The course language is English.

227-0526-00L Power System Analysis

W 6 credits 4G G. Hug

Abstract

The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Objective

The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Content

The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand oriented, operationally, economically), network planning and network operation, models of N-port network components (line, cables, shunts, transformers), the p.u. computation, computer oriented network models, linear networks (solution methods - direct, iterative), algorithms for the solution of non-linear sets of equations, derived from the electrical power system (Newton-Raphson), power flow computation (problem definition, solution methods), three phase short-circuit computation, application of power flow algorithms. Introduction to power system stability.

Lecture notes

Lecture notes. Course is supported by WWW-teaching system.

227-0697-00L Industrial Process Control

W 4 credits 3G G. Maier, A. Horch

Abstract

Introduction to process automation and its application in process industry and power generation

Objective

Knowledge of process automation and its application in industry and power generation

Prerequisites / notice

Prerequisites: Introductory course on power electronics.
Introduction to process automation: system architecture, data handling, communication (fieldbusses), process visualization, engineering, etc.

Analysis and design of open loop control problems: discrete automata, decision tables, petri-nets, drive control and object oriented function group automation philosophy, RT-ULM. 

Engineering: Application programming in IEC61131-3 (function blocks, sequence control, structured text); process visualization and operation; engineering integration from sensor, cabling, topology design, function, visualization, diagnosis, to documentation; Industry standards (e.g. OPC, Profibus); Ergonomic design, safety (IEC61508) and availability, supervision and diagnosis.

Practical examples from process industry, power generation and newspaper production.

Slides will be available as .PDF documents, see "Learning materials" (for registered students only)

Practical exercises will illustrate some topics, e.g. some control software coding using industry standard programming tools based on IEC61131-3.

<table>
<thead>
<tr>
<th>Lecture notes / notice</th>
<th>Content</th>
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<tbody>
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<table>
<thead>
<tr>
<th>227-0778-00L</th>
<th>Hardware/Software Codesign</th>
<th>W</th>
<th>6 credits</th>
<th>2V+2U</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.</td>
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<tr>
<td>Objective</td>
<td>The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.</td>
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<tr>
<td>Content</td>
<td>The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware-Software Interfaces (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures, System-on-Chip), (c) Application specific instruction sets, code generation and retargetable compilation, (d) Performance analysis and estimation techniques, (e) System design (hardware/software partitioning and design space exploration).</td>
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<tr>
<td>Lecture notes</td>
<td>Material for exercises, copies of transparencies.</td>
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<table>
<thead>
<tr>
<th>227-0920-00L</th>
<th>Seminar in Systems and Control</th>
<th>Z</th>
<th>0 credits</th>
<th>1S</th>
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</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Current topics in Systems and Control presented mostly by external speakers from academia and industry</td>
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<tr>
<td>Objective</td>
<td>see above</td>
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<tr>
<th>252-0535-00L</th>
<th>Machine Learning</th>
<th>W</th>
<th>8 credits</th>
<th>3V+2U+2A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.</td>
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<tr>
<td>Objective</td>
<td>Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.</td>
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<tr>
<td>Content</td>
<td>The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.</td>
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<tr>
<td>Lecture notes</td>
<td>No lecture notes, but slides will be made available on the course webpage.</td>
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<table>
<thead>
<tr>
<th>252-1407-00L</th>
<th>Algorithmic Game Theory</th>
<th>W</th>
<th>7 credits</th>
<th>3V+2U+1A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.</td>
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<tr>
<td>Objective</td>
<td>Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.</td>
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</tbody>
</table>
Content

The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classic game-theoretic concepts
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization.
- Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the 'Price of Anarchy').
- Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium.
- Selected current research topics, such as Google's Sponsored Search Auction, the U.S. FCC Spectrum Auction, Kidney Exchange.

Lecture notes

No lecture notes.

Literature

"Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

Prerequisites / notice

Several copies of both books are available in the Computer Science library.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Winter</th>
<th>Exam Session</th>
<th>Prerequisites / notice</th>
</tr>
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<tbody>
<tr>
<td>252-3110-00L</td>
<td>Human Computer Interaction</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>O. Hilliges, M. Norrie</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides an introduction to the field of human-computer interaction, emphasising the central role of the user in system design. Through detailed case studies, students will be introduced to different methods used to analyse the user experience and shown how these can inform the design of new interfaces, systems and technologies.</td>
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<tr>
<td>Objective</td>
<td>The goal of the course is that students should understand the principles of user-centred design and be able to apply these in practice.</td>
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<tr>
<td>Content</td>
<td>The course will introduce students to various methods of analysing the user experience, show how these can be used at different stages of system development from requirements analysis through usability testing. Students will gain experience of designing and carrying out user studies as well as analysing results. The course will also cover the basic principles of interaction design. Practical exercises related to touch and gesture-based interaction will be used to reinforce the concepts introduced in the lecture. To get students to further think beyond traditional systems design, we will discuss issues related to ambient information and awareness.</td>
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<tr>
<td>Literature</td>
<td>The papers will be presented in the first session of the seminar.</td>
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</table>

| 252-5051-00L| Advanced Topics in Machine Learning                | W       | 2      | 2S           | J. M. Buhmann, T. Hofmann, A. Krause, G. Rätsch |
| Abstract    | In this seminar, recent papers of the pattern recognition and machine learning literature are presented and discussed. Possible topics cover statistical models in computer vision, graphical models and machine learning. |         |        |              |                        |
| Objective   | The seminar "Advanced Topics in Machine Learning" familiarizes students with recent developments in pattern recognition and machine learning. Original articles have to be presented and critically reviewed. The students will learn how to structure a scientific presentation in English which covers the key ideas of a scientific paper. An important goal of the seminar presentation is to summarize the essential ideas of the paper in sufficient depth while omitting details which are not essential for the understanding of the work. The presentation style will play an important role and should reach the level of professional scientific presentations. |         |        |              |                        |
| Content     | The seminar will cover a number of recent papers which have emerged as important contributions to the pattern recognition and machine learning literature. The topics will vary from year to year but they are centered on methodological issues in machine learning like new learning algorithms, ensemble methods or new statistical models for machine learning applications. Frequently, papers are selected from computer vision or bioinformatics - two fields, which relies more and more on machine learning methodology and statistical models. |         |        |              |                        |
| Literature  | The papers will be presented in the first session of the seminar. |         |        |              |                        |

| 252-5701-00L| Advanced Topics in Computer Graphics and Vision    | W       | 2      | 2S           | M. Gross, O. Sorkine Hornung |
| Number of participants limited to 24. | | | | | |
| Abstract    | This seminar covers advanced topics in computer graphics, such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each time the course is offered, a collection of research papers is selected and each student presents one paper to the class and leads a discussion about the paper and related topics. |         |        |              |                        |
| Objective   | The goal is to get an in-depth understanding of actual problems and research topics in the field of computer graphics as well as improve presentations and critical analysis skills. |         |        |              |                        |
| Content     | This seminar covers advanced topics in computer graphics, including both seminal research papers as well as the latest research results. Each time the course is offered, a collection of research papers is selected covering topics such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each student presents one paper to the class and leads a discussion about the paper and related topics. |         |        |              |                        |
| Lecture notes | Individual research papers are selected each term. See http://graphics.ethz.ch/ for the current list. | | | | |
| Literature  | The seminars "Computer Graphics I and II" (GDV I & II) are recommended, but not mandatory. |         |        |              |                        |

| 263-5210-00L| Probabilistic Artificial Intelligence             | W       | 4      | 2V+1U        | S. Tschitschek |
| Abstract    | This course introduces core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. |         |        |              |                        |
| Objective   | How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit "intelligent" behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. The course is designed for upper-level undergraduate and graduate students. |         |        |              |                        |

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1360 of 1571
Content
Topics covered:
- Search (BFS, DFS, A*), constraint satisfaction and optimization
- Tutorial in logic (propositional, first-order)
- Probability
- Bayesian Networks (models, exact and approximative inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
- Probabilistic palning (MDPs, POMDPs)
- Reinforcement learning
- Combining logic and probability

Prerequisites / notice
Solid basic knowledge in statistics, algorithms and programming

263-5902-00L

Computer Vision

Abstract
The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

Objective
The objectives of this course are:
1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve those.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

Content
Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

Prerequisites / notice
It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

376-1279-00L

Virtual Reality in Medicine

Abstract
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (audiovisual, haptic, tactile etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, interactive operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Objective
Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation.

Content
Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, interactive operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Prerequisites / notice
The course language is English.
Basic experience in Information Technology and Computer Science will be of advantage
More details will be announced in the lecture.

376-1504-00L

Physical Human Robot Interaction (pHRI)

Number of participants limited to 26.

Abstract
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human-factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

Objective
The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and de- sign safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

Content
This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://www.relab.ethz.ch/education/courses/phi/request-efhz-haptic-paddle-hardware-documentation.html), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.
Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods. For dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs). The lecture will be held in English.

Any courses offered by the Departments of MAVT, ITET or INFN. Your tutor must agree to this choice.

### GESS Science in Perspective

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

### Semester Project

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### Semester Project Robotics, Systems and Control

**Number**
151-1014-00L

**Title**
Semester Project Robotics, Systems and Control

**Type**
O

**ECTS**
8 credits

**Hours**
17A

**Lecturers**
Professors

**Abstract**
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

**Objective**
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program.

### Internship

**Number**
151-1015-00L

**Title**
Industrial Internship Robotics, Systems and Control

**Type**
O

**ECTS**
8 credits

**Hours**
external organisers

**Lecturers**

**Abstract**
The main objective of the 12-week internship is to expose master's students to the work environment in an engineering company or in a research lab outside of the ETH domain. During this period, students have the opportunity to be involved in on-going projects at the host institution.

**Objective**
The main objective of the 12-week internship is to expose master's students to the work environment in an engineering company or in a research lab outside of the ETH domain.

### Master's Thesis

**Number**
151-1016-00L

**Title**
Master's Thesis Robotics, Systems and Control

**Type**
O

**ECTS**
30 credits

**Hours**
64D

**Lecturers**
Professors

**Abstract**
Students who fulfill the following criteria are allowed to begin with their Master's Thesis:

- a. successful completion of the bachelor program;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme;
- c. successful completion of the semester project;
- d. achievement of 28 ECTS in the category "Core Courses".

The Master's Thesis must be approved in advance by the tutor and is supervised by a professor of ETH Zurich or an adjunct faculty of RSC. To choose a titular professor as a supervisor, please contact the D-MAVT Student Administration.

**Objective**
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

---

**Robotics, Systems and Control Master - Key for Type**

| O   | Compulsory                  | E- | Recommended, not eligible for credits |
| W+  | Eligible for credits and recommended | Z  | Courses outside the curriculum       |
| W   | Eligible for credits        | Dr | Suitable for doctorate               |

**Key for Hours**

| V   | lecture                     | P  | practical/laboratory course         |
| G   | lecture with exercise       | A  | independent project                 |
| U   | exercise                    | D  | diploma thesis                      |
| S   | seminar                    | R  | revision course / private study     |
| K   | colloquium                  |    |                                      |

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>860-0003-00L</td>
<td>Cornerstone Science, Technology, and Policy</td>
<td>O</td>
<td>2</td>
<td>2S</td>
<td>T. Bernauer, R. S. Abhari</td>
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<td></td>
<td>Only for Science, Technology, and Policy MSc.</td>
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<tr>
<td>Abstract</td>
<td>This course introduces students to the MSc program in two ways. First, it provides a general introduction to the study of STP. Second, it exposes students to a variety of complex policy problems and ways and means of coming up with proposals for and assessments of policy options.</td>
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<td>Objective</td>
<td>This course introduces students to the MSc program in two ways. First, it provides a general introduction to the study of STP. Second, it exposes students to a variety of complex policy problems and ways and means of coming up with proposals for and assessments of policy options.</td>
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<tr>
<td>Content</td>
<td>Day 1: Introduction to the study of Science, Technology and Policy / getting to know each other, social event Day 2: Knowledge assessment in areas marked by controversy over scientific evidence Day 3: Challenges of urban development / Energy transition and sustainable mobility Day 4: Mitigating and adapting to climate change / Managing international water resources Day 5: Implications of digital society / Policy planning exercise</td>
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<td>Prerequisites</td>
<td>Reserved for the ISTP's Master students</td>
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<tr>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>860-0002-00L</td>
<td>Quantitative Policy Analysis and Modeling</td>
<td>O</td>
<td>6</td>
<td>4G</td>
<td>A. Patt, T. Schmidt, E. Trutnevye, O. van Vliet</td>
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<tr>
<td>Abstract</td>
<td>The lectures will introduce students to the principles of quantitative policy analysis, namely the methods to predict and evaluate the social, economic, and environmental effects of alternative strategies to achieve public objectives. A series of graded assignments will give students an opportunity for students to apply those methods to a set of case studies</td>
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<tr>
<td>Objective</td>
<td>The objectives of this course are to develop the following key skills necessary for policy analysts: - Identifying the critical quantitative factors that are of importance to policy makers in a range of decision-making situations. - Developing conceptual models of the types of processes and relationships governing these quantitative factors, including stock-flow dynamics, feedback loops, optimization, sources and effects of uncertainty, and agent coordination problems. - Develop and program numerical models to simulate the processes and relationships, in order to identify policy problems and the effects of policy interventions. - Communicate the findings from these simulations and associated analysis in a manner that makes transparent their theoretical foundation, the level and sources of uncertainty, and ultimately their applicability to the policy problem. The course will proceed through a series of policy analysis and modeling exercises, involving real-world or hypothetical problems. The specific examples around which this work will be done will concern the environment, energy, health, and natural hazards management.</td>
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<tr>
<td>Content</td>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>860-0004-00L</td>
<td>Bridging Science, Technology, and Policy</td>
<td>O</td>
<td>3</td>
<td>2S</td>
<td>R. S. Abhari, T. Bernauer</td>
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<tr>
<td>Abstract</td>
<td>This course focuses on technological innovations from the beginning of humanity through the industrial revolution up until today. It provides students with a deeper understanding of the factors that drive technological innovations, and the roles government policies, society, science, and industry play in this regard.</td>
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<tr>
<td>Objective</td>
<td>This course picks up on the ISTP Cornerstone Science, Technology and Policy course and goes into greater depth on issues covered in that course, as well as additional issues where science and technology are among the causes of societal challenges but can also help in finding solutions.</td>
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<tr>
<td>Lecture notes</td>
<td>Course materials will be given to the students prior to the start of each class</td>
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<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>860-0005-00L</td>
<td>Colloquium Science, Technology, and Policy (HS)</td>
<td>O</td>
<td>1</td>
<td>2K</td>
<td>T. Bernauer, R. S. Abhari</td>
</tr>
<tr>
<td></td>
<td>Students of Science, Technology, and Policy MSc have priority.</td>
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<tr>
<td>Abstract</td>
<td>Presentations by invited guest speakers from academia and practice/policy. Students are assigned to play a leading role in the discussion and write a report on the respective event.</td>
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<tr>
<td>Content</td>
<td>See program on the ISTP website: <a href="http://www.istp.ethz.ch/news-and-events/events.html">http://www.istp.ethz.ch/news-and-events/events.html</a> open to anyone from ETH</td>
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<tr>
<td>Prerequisites</td>
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<tr>
<td>Abstract</td>
<td>This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.</td>
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Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1364 of 1571
Students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, as well as the potentials and limitations of economic policies to govern the behavior of individuals and the economy. The course is divided into two parts, the first covering microeconomic analysis, and the second on macroeconomics.

Objective

The first part of the course focuses on microeconomic analysis, including the behavior of individuals and firms, supply and demand analysis, and market failures. Students will also be introduced to the use of microeconomic thought to influence the behavior of individuals and firms and to address market failures. The second part focuses on macroeconomic concepts, including national production, employment, inflation, and growth theories. Students will then learn about macroeconomic policies, such as monetary and fiscal policy, often used to stabilize short-run economic fluctuations.

Content

This course is an introduction to the study of economics. Students learn about the economic way of thinking, the functioning of a market economy, as well as the potentials and limitations of economic policies to govern the behavior of individuals and the economy. The course is divided into two parts, the first covering microeconomic analysis, and the second on macroeconomics.

Lecture notes

Lecture slides will be made available by email or via course website.

Literature


860-0001-00L  
Public Institutions and Policy-Making Processes  
Priority for Science, Technology, and Policy MSc students.

Number of participants limited to 25.

Abstract

Students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels, and what challenges arise in this regard.

Objective

Public policies result from decision-making processes that take place within formal institutions of the state (parliament, government, public administration, courts). That is, policies are shaped by the characteristics of decision-making processes and the characteristics of public institutions and related actors (e.g. interest groups). In this course, students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels, and what challenges arise in this regard. The course is organized in three modules. The first module (Stefan Bechtold) examines basic concepts and the role of law, law-making, and law enforcement in modern societies. The second module (Thomas Bernauer) deals with the functioning of legislatures, governments, and interest groups. The third module (Frank Schimmelfennig) focuses on the European Union and international organisations.

Content

Schedule (for up-to-date information, see the syllabus that will be distributed to participants electronically):

W1: Bechtold, Bernauer: Introduction

How are laws created and interpreted? How are they enforced?

W2: Bechtold: Why do we need laws and why do people and firms usually obey the law? What are possible goals of legal systems? What is the relationship between laws, social norms, and moral values?

W3: Bechtold: What role does scientific evidence play in the creation and enforcement of the law? How does the law deal with non-quantifiable factors or incommensurable values?

W4: no class

W5: Bernauer: How are parliaments (legislatures) elected, how do they work, and how do their characteristics and processes affect policy-making?

W6: Bernauer: Why do forms of government differ and how does this affect policy-making? Why and in what respect are public administrations efficient/effective, and why sometimes not?

W7: Bernauer: How do interest groups and social movements affect policy-making.

W8: Study week

W9: Schimmelfennig: Governance beyond the state: why and how states create international institutions.

W10: Schimmelfennig: International organizations and regimes: case studies of global governance.

W11: Schimmelfennig: Institutions and policy-making in the European Union.

W12: Schimmelfennig: International organizations and policy diffusion.

W13: End-of-semester exam

An add-on module to this course (3 ECTS) involves an essay. This part of the course is accessible only to ISTP MSc students and requires enrollment in the main course (3 ECTS). ISTP MSc students must enrol in both parts. Other students can only enrol in the main course.

3rd week of January: deadline for review essay

Lecture notes

Reading materials will be distributed electronically to the students when the semester starts.
This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world. Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at “tipping points”, multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or “tragedies of the commons” such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating techno-socio-environmental problems, and what data science may contribute to their solution.

Prerequisites / notice

860-0011-00L Modelling and Simulating Social Systems with MATLAB (with Coding Project)
Prerequisites: solid mathematical skills. Particularly suitable for students of D-ITET, D-MAVT
Prerequisite: you have to be enrolled in 860-0001-00L during the same semester.

Abstract
This course introduces the mathematical software package MATLAB. Students should learn to implement models of various social processes and systems, and document their skills by a seminar thesis, a short oral presentation as well as a coding project.
The students should learn how to use MATLAB as a tool to solve various scientific problems. MATLAB is an integrated environment with a high level programming language which makes it possible to quickly find numerical solutions to a wide range of scientific problems. Furthermore, it includes a rich set of tools for graphically presenting the results.

After the students have learned the basic structure of the programming language, they should be able to implement social simulation models in MATLAB and document their skills by a seminar thesis, a coding project and finally give a short oral presentation.

**Objective**

Discovering Management (Exercises) 351-0778-01L

Complementary exercises for the module Discovering Management.

**Prerequisite:** Participation and successful completion of the module Discovering Management (351-0778-00L) is mandatory.

**Abstract**

This course is offered complementary to the basis course 351-0778-00L, "Discovering Management". The course offers additional exercises and case studies.

**Objective**

This course is offered to complement the course 351-0778-00L. The course offers additional exercises and case studies.

**Content**

The course offers additional exercises and case studies concerning:

- Strategic Management
- Technology and Innovation Management
- Operations and Supply Chain Management
- Finance and Accounting
- Marketing and Sales.

Please refer to the course website for further information on the content, credit conditions and schedule of the module: www.dm.ethz.ch

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**Objective**

- To recognize current challenges in the energy system to understand the theoretical frameworks and concepts for studying transitions
- To demonstrate knowledge and appreciation for the role of policy and politics in energy transitions

The course broadens the view and understanding of technology by linking it with its commercial applications and with society. The lectures are designed to introduce students to topics related to strategy, corporate innovation, leadership, corporate social responsibility, and business model innovation. Practical examples from industry experts will stimulate the students to critically assess these issues. Creative skills will be trained by the business game exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of Chief Innovation Officer of a large multinational company. As they learn more about the specific case and identify the challenge they are facing, they will have to develop an innovative business case for this multinational company. Doing so, this exercise will provide an insight into the context of managerial problem-solving and corporate innovation, and enhance the students' appreciation for the complex tasks companies and managers deal with. The business game presents a realistic model of a company and provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyse the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

**Prerequisites / notice**

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich.

No prior knowledge of business or economics is required to successfully complete this course.

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**Objective**

- To gain an overview of the history of the transition of large technical systems
- To demonstrate knowledge and appreciation for the role of policy and politics in energy transitions

This course addresses the role of policy and its underlying politics in the transformation of the energy sector. It covers historical, socioeconomic, and political perspectives and applies various theoretical concepts to specific aspects of governing the energy transition. Primarily suited for Master and PhD level

**Abstract**

This course introduces the social and environmental challenges involved in the energy sector and discusses the implications of these challenges for the rate and direction of technical change in the energy sector. It compares the current situation with historical socio-technical transitions and derives the consequences for policy-making. It then introduces theoretical frameworks and concepts for studying innovation and transitions. It then focuses on the role of policy and policy change in governing the energy transition, considering the role of political actors, institutions and policy feedback.

**Content**

Climate change, access to energy and other societal challenges are directly linked to the way we use and create energy. Both the recent

**Lecture notes**

Slides and reading material will be made available via moodle.ethz.ch.

**Prerequisites / notice**

This course is particularly suited for students of the following programmes: MA Comparative International Studies; MSc Energy Science & Technology; MSc Environmental Sciences; MSc Management, Technology & Economics; MSc Science, Technology & Policy; ETH & UZH PhD programmes.

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Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1367 of 1571
During the course, students will learn about different design thinking methods and tools. This will enable them to:

- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.
- Engage in collaborative ideation with key stakeholders in order to develop an in-depth understanding of what is truly important and emotionally meaningful to the people at the center of a problem. Based on these insights, the students ideate on possible solutions and immediately validated them through quick iterations of prototyping and testing using different tools and materials. The students will work in multidisciplinary teams on a set of challenges that are organized as a one-week, a three-week, and a final six-week project in collaboration with an external project partner.

The purpose of this course is to equip the students with methods and tools to tackle a broad range of problems. Following a Design Thinking approach, the students will learn how to observe and interact with key stakeholders in order to develop an in-depth understanding of the essential methods of project appraisal, multi-criteria analysis, European guidelines, stated response methods, travel cost approach and others; Valuation of travel time savings; valuation of traffic safety cost

Design Thinking is a deeply human process that taps into the creative abilities we all have, but that get often overlooked by more conventional problem solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as functional, and to express ourselves through means beyond words or symbols. Design Thinking provides an integrated way by incorporating tools, processes and techniques from design, engineering, the humanities and social sciences to identify, define and address diverse challenges. This integration leads to a highly productive collaboration between different disciplines.

The goal of this course is to engage students in a multidisciplinary collaboration to tackle real world problems. Following a design thinking approach, students will work in teams to solve a set of design challenges that are organized as a one-week, a three-week, and a final six-week project with an external project partner.

Additionally please enroll via mystudies. Places will be assigned after the first lecture on the basis of your motivation letter and commitment for the class.

Information and application: www.sparklabs.ch/ethz

For more information and the application visit: http://sparklabs.ch/ethz

Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

**Internship**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>860-0800-00L</td>
<td>Internship</td>
<td>W</td>
<td>0</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

**Prerequisites / notice**

Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

**Master's Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>860-0900-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>
You will receive full support on-site from the Polytechnic University José Antonio Echeverría, La Habana (PUJAE) and ETH tutors from Winter School: Low-Carbon Energy and Development.

Cities on the border or an outpost of Western European influence, struggling between globalization, modernization and local traditions, are the subject of this thesis. The thesis should demonstrate the students' ability to conduct independent research on the basis of the theoretical and methodological knowledge acquired during the MSc program.

The correlation between consumption of modern forms of energy and long-term economic growth and development is well documented. Moreover, the lack of resources in cities of the Global South often prevents the gathering of modern, digitalized data, while the unstable political structures prevent the implementation of durable planning strategies. These cities need a rapid assessment procedure, in order to plan and implement strategies that can address fragmented conditions within cities, while using quantitative and qualitative data.

Students will understand the multi-faceted challenges of developing and implementing a low-carbon energy development strategy (LCEDS) and how to address them. During the three weeks, they will develop LCEDS for specific countries in interdisciplinary teams, as if they were consultants to the national governments of these countries. They will integrate technical, socio-economic, and policy knowledge. The students’ LCEDS proposals will be evaluated at the end of the three weeks by a team of experts.

The following ETH Master courses are relevant: MEST, ISTP, MA CIS, MTEC, all engineering types (esp. BAUG, ITET, MAVT).

At this very moment, the political and economical situation is changing rapidly, with a contradictory process of economic and social opening that becomes now more and more visible in the streets of Havana, with new businesses, restaurants and street activities, announcing further changes in everyday life. How can such fragmented conditions within cities be tackled by integrated and inclusive solutions, rather than fragmented interventions that exclude the challenged local communities?

Moreover, the lack of resources in cities of the Global South often prevents the gathering of modern, digitalized data, while the unstable political structures prevent the implementation of durable planning strategies. These cities need a rapid assessment procedure, in order to identify relevant priorities and potentials. How can we create a comprehensive understanding of the system and propose appropriate solutions, while using quantitative and qualitative data?

The summer school will build on the current "Atlas Urbano de La Havana - Urban Atlas of Havana" and on the project SeDUT (Seminario Internacional de Desarrollo Urbano y Transporte), a three-year Swiss-Cuban cooperative research project on the urban development of Havana and its mobility potentials. The SeDUT project involved many academic, governmental and private stakeholders, such as the Polytechnic University José Antonio Echeverría, the Centro de Estudios Urbanos de La Habana, the Instituto de Planificación Física, the Dirección Provincial de Planificación Física de la Ciudad de La Habana and the design office of Metron AG. Together they represent an important expertise and a high degree of accumulated knowledge.

In a team, you will produce alternative urban scenarios for the planned redevelopment of the Old Port of Havana. You will contribute your expertise and unpack the realities of sustainable development in a tropical climate. How can knowledge from the ETH be combined with Cuban research and translated to a Caribbean context? Through debate, controversy and collaboration it is expected you produce scenarios that integrate your different disciplines and question the preconceptions of sustainable urban development.

This immersive summer school will be structured in three interlocking modules:

1. The first module you will investigate the Old Port and gain a strong understanding of the social, environmental and built context in Havana. You will employ analytical mapping to integrate and synthesize different disciplinary knowledge, ranging from quantitative data to subjective observation.

2. In the second module, you will develop a series of scenarios for the Old Port, proposing alternatives for its sustainable future. You will build on the research from the first module, and explore the potential of your ideas with local stakeholders and professionals from your field. You will document these scenarios using creative and varied representational methods.

3. In the final module you will pitch your scenarios to decision makers. During this event you will measure their preferences, debate the associated trade-offs, and provide a series of orientations for those planning the future of Havana.

More information on: http://u-tt.com/teaching/havana-summer-school/

Complementary Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>860-0020-00L</td>
<td>Winter School: Low-Carbon Energy and Development Strategies</td>
<td>Z</td>
<td>4</td>
<td>8S</td>
<td>T. Schmidt</td>
</tr>
<tr>
<td>051-0821-16L</td>
<td>Summer School: Learning from Havana</td>
<td>Z</td>
<td>4</td>
<td>4G</td>
<td>H. Klumpner, A. Brillembourg, M. Menendez, C. Schmid</td>
</tr>
</tbody>
</table>

Literature

More information on: http://u-tt.com/teaching/havana-summer-school/
Who should apply?

Enthusiastic students currently enrolled in a masters program in ETH Zurich and PUJAE Havana. A balanced group of 15 ETH master students from the D-ARCH, D-BAUG, D-GESS and D-USYS departments will be selected. They will be joined by 15 Cuban students from our partner university.

Applicants should have a strong interest in sustainable urban development and transdisciplinary collaborative research. They should be able to demonstrate their academic strength, motivation, interest and expertise. Knowledge of Spanish is welcome but not obligatory.

Dates in Cuba: 21 August to 1st of September.
Contact: Marie Grob at grob@arch.ethz.ch, enrollment procedure on our webpage.

Science, Technology, and Policy Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Sport Teaching Diploma

Detailed information on the programme at: www.didaktischeausbildung.ethz.ch

Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-15L</td>
<td>Designing Educational Environments in Physical Education (EW2 Sport)</td>
<td>O</td>
<td>4 credits</td>
<td>2S</td>
<td>H. Gubelmann, R. Scharpf</td>
</tr>
</tbody>
</table>
| Abstract    | Students learn principles of teaching beyond classroom and regular PE-Lessons:
- Planning and organizing camps and events
- Teaching the "Ergänzungsfach Sport"
- Long-term-curricula in PE
As a practical part students design the Outdoor event in EW4 of the following term |
| Objective   | Students know
- How to plan events and camps
- To assess curricula critically and to use them properly
- How to combine theoretical and practical issues in the ‘Ergänzungsfach’ |
| Content     | 1. LV Semestereinführung
2. LV Planung Outdoor-Weekend
3. LV Auswertung Outdoor-Event
4. LV Planung Event
5. LV Event-Präsentationen / Schlussveranstaltung |
| Prerequisites / notice | EW2 is compulsory requirement for EW4 Sport |

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
| Content     | Thematische Schwerpunkte:
Lernen als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wissentransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen; Intelligenztheorien, Geschlechtsunterschiede beim Lernen |
| Lecture notes | Folien werden zur Verfügung gestellt. |
| Prerequisites / notice | This lecture is only apt for students who intend to enrol in the programs "Teaching Diploma" or "Didaktisches Zertifikat". It is about learning in childhood and adolescence. |

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-02L</td>
<td>Research Methods in Educational Science Number of participants limited to 30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)"
|
| Abstract    | Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work. |
| Objective   | - Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences |

Subject Didactics in Sport

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0203-00L</td>
<td>Mentored Work Subject Didactics Sport A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Only for Sport Teaching Diploma students. |
| Abstract    | Simultaneous enrolment in Mentored Work Subject Didactics Sport A and B is compulsory |
| Objective   | In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle. |
| Notice      | planning and organization of a longer period of instruction in school. |
Planning and organization of a longer period of instruction in school

During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and observe and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.

Practical implementation in sports of general didactics, with the planning, implementation and evaluation of topics from all the sports-specific areas of tuition.

- Implement the objectives of general didactics in respect of the different types of sport at school.
- master the planning, implementation and evaluation of topics from all the sports-specific areas of tuition.
- try out different teaching structures, such as the lesson, teaching unit, block periods and extra units in sport in addition to those on the timetable.
- gain an overview of the preparation necessary for the different requirements placed on a sports teacher at secondary school Level II.

Implementation of practical sport into general teacher training with planning, execution and evaluation of the topics from all sport-specific areas of tuition in secondary school Level II.

- Try out different teaching structures, such as the lesson, teaching unit, block periods and extra units in sport in addition to those on the timetable.
- Gain an overview of the preparation necessary for the different requirements placed on a sports teacher at secondary school Level II.

Professional Training

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0210-00L</td>
<td>Introductory Internship Sport</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>O. Graf, R. Scharpf</td>
</tr>
<tr>
<td>557-0315-00L</td>
<td>Sport Didactics I</td>
<td>O</td>
<td>4 credits</td>
<td>2V</td>
<td>R. Scharpf, O. Graf</td>
</tr>
</tbody>
</table>

Simultaneous enrollment in Introductory Internship Sport - course 557-0210-00L - is compulsory.

Abstract

Practical implementation in sports of general didactics, with the planning, implementation and evaluation of topics from all the sports-specific areas of tuition in secondary school Level II.

Objective

The students:

- Implement the objectives of general didactics in respect of the different types of sport at school.
- master the planning, implementation and evaluation of topics from all the sports-specific areas of tuition.
- try out different teaching structures, such as the lesson, teaching unit, block periods and extra units in sport in addition to those on the timetable.
- Gain an overview of the preparation necessary for the different requirements placed on a sports teacher at secondary school Level II.

Content

Implementation of practical sport into general teacher training with planning, execution and evaluation of the topics from all sport-specific areas of the education at this level in Section II.

Lecture notes

Skript unter: https://moodle-app2.let.ethz.ch/course/view.php?id=117>

Lehrmittel Sportwissenschaftliches Lexikon, Schorndorf Verlag 1997/98

Literature

Röthig P. & s. Grössing (Hrsg.) Bewegungslehre, Kursbuch 3, Wiesbaden 1990/3

Roth K. & K. Willemczik, Bewegungswissenschaft, Rowohlt Verlag Reinbek 1999

Röthig P. Sportwissenschaftliches Lexikon, Schorndorf Verlag 2003

Röthig P. & s. Grössing (Hrsg.) Bewegungslehre, Kursbuch 3, Wiesbaden 1990/3

Simultaneous enrollment in Introductory Internship Sport - course 557-0210-00L - is compulsory.

Abstract

During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.

Objective

Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

Content

Students observe and teach 5 lessons, supervised by experienced teachers

Lecture notes

see moodle 00 - Lehrexpertise Sport
https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php

Simultaneous enrollment in Sport Didactics I - course 557-0315-00L - is compulsory.

Abstract

The students:

- Implement the objectives of general didactics in respect of the different types of sport at school.
- master the planning, implementation and evaluation of topics from all the sports-specific areas of tuition.
- try out different teaching structures, such as the lesson, teaching unit, block periods and extra units in sport in addition to those on the timetable.
- Gain an overview of the preparation necessary for the different requirements placed on a sports teacher at secondary school Level II.
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

Students apply teaching methods they learned in Didactics I and II in practical lessons in the gym hall. They also supervise their fellow students and give feedback.

Together with their supervisors they learn to assess their tasks and achievements.

They know how to judge topics of their subject and can present them in class.

They know the key points of good teaching and can apply them in their lessons.

They become experts in planning, teaching and analyzing lessons in all fields of sports that are part of school curricula.

They know the principles of learning and are able to promote them with different methods.

They manage and learn how to interact with pupils. Together with their supervisor they develop an ability of critical reflection of their tasks.

They know how to judge topics of their subject and can present them in class.

Simultaneous enrolment in "Examination Lesson II Sport lower" (557-0211-01L) is compulsory.

In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

Simultaneous enrolment in "Examination Lesson II Sport lower" (557-0211-02L) is compulsory.
Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

Die Studierenden erfahren das Lektionsthema in der Regel eine Woche vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten sie Informationen über den Wissensstand der zu unterrichtenden Klasse und können sie vor dem Prüfungstermin besuchen.

Die gehaltene Lektion wird kriteriумbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/ der Kandidatin über die gehaltene Lektion im Rahmen eines kurzen Kolloquiums.

Dokument: Schriftliche Vorbereitung für Prüfungslektionen.

Nach Abschluss der übrigen Ausbildung.


★★ Specialized Courses in Respective Subject with Educational Focus I

At least 6 CPs must be obtained in this category.

Number Title Type ECTS Hours Lecturers
376-1033-00L History of Sports W 2 credits 2V M. Gisler

Abstract
Comprehension for development and changes of sports from the ancient world to the presence. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.

Objective
Understanding for the development and adaptation of sports from the ancient world to present times.

Content

Lecture notes
Ein Skript für die aktuelle Veranstaltung wird abgegeben.

Literature

376-1107-00L Sport Pedagogy W 2 credits 2V D. Seiler Hubler

Abstract
Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

Objective
To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.

Content
Inhaltsliche Schwerpunkte der Vorlesung sind:
- Einführung in die Sportpedagogik und die pädagogische Psychologie des Sportunterrichts
- Bedeutung des Sports im Jugendalter
- Zeitgemässes Sportunterricht
- Sport und Leistung
- Heterogenität im Sportunterricht
- Sport und Gesundheit
- Geschlechterfragen im Sport
- Soziale und moralische Entwicklung im Sportunterricht

Lecture notes
Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

376-1117-00L Sport Psychology W 2 credits 2V H. Gubelmann

Abstract
This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.

Objective
Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students' expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

Content
Main Topics
- Introduction to sport psychology
- Cognitions in sports: mental rehearsal and mental training
- Emotions and stress
- Motivation: goal-setting in sports
- Career and career transition in elite sport
- Coach-Athlete-Interaction
- Psychological aspects of sport-injury rehabilitation
- Group dynamics in sport

Lecture notes
Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

Literature


376-1127-00L Sociology of Sport W 2 credits 2V M. Lamprecht

Abstract
These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.

Objective
The lectures set out to:
- present the different dimensions, functions and interrelationships of present-day sport
- provide an introduction to the central theories and models of (sport) sociology
- show how far sport reflects society and how it changes and becomes more differentiated in the process
- take current examples from newspapers, magazines and television to highlight the sociological view of sport.

Content
Sport and social change: developments and trends
- The economy and the media: dependencies, consequences, scandals
- Social inequalities and distinctions: gender differences and group behavior
- Conflicts and politics: sports organizations, doping, violence

Lecture notes
Selected materials for the lecture are available under www.LSSFB.ch --> Lehre
A detailed program with additional references will be delivered at the beginning of the lecture.

<table>
<thead>
<tr>
<th>Number</th>
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<td>Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Sport</td>
<td>2 credits</td>
<td>4A</td>
<td>R. Scharpf, O. Graf</td>
<td></td>
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<tr>
<td>557-0206-00L</td>
<td>Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Sport</td>
<td>2 credits</td>
<td>4A</td>
<td>R. Scharpf, O. Graf</td>
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</table>

**Specialized Courses in Respective Subject with Educational Focus II**

At least 6 CP’s must be obtained in this category. Further courses must be chosen from the “Sport Practical: Major Education and Specialized Education”.

**Compulsory Elective Courses**

At least 6 CP’s must be acquired in this category. Further courses must be chosen from the “Sport Practical: Major Education and Specialized Education”.

**Sport Practical**

The Teaching Diploma in Sport will only be granted to students holding a Master, Diploma or Licentiate degree in Sport. Additionally, a Sport Practical encompassing 56 CP’s is required. The Sport Practical can be partly conducted during the Bachelor and Master programmes in Sport.
#### Assessments

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>557-0103-00L</td>
<td>Assessment II</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>A. Krebs, S. Nüssli</td>
</tr>
</tbody>
</table>

**Abstract**
The assessment II 'achievement' allows students to continue their studies in the basic subjects of athletics, fitness, swimming, ice sports and trend sports. Aim is to acquire the basic skills for the respective sports discipline.

**Objective**
The assessment monitors both the physical fitness of the students and their skills in the fields of athletics and fitness, which forms the basis for a successful rounding off of the respective direction of study.

**Content**
Im Assessment II Leisten werden einige Elemente der Sportarten Fitness und Leichtathletik erworben. Unter anderem Grundschritte Aerobic, wesentliche Übungen zur Körperkräftigung, Gewandtheit, Hochsprung, Kugelstossen und Ausdauer.

**Prerequisites / notice**
Kenntnisse (Schulniveau) in den Sportfächern Fitness und Leichtathletik werden ebenso vorausgesetzt wie angemessene konditionelle Fähigkeiten.

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<tr>
<th>Number</th>
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<tr>
<td>557-0101-00L</td>
<td>Assessment I</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>B. Mattli Baur, M. M. Jaeggi</td>
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</tbody>
</table>

**Abstract**

**Objective**

**Content**

**Lecture notes**
During the semester the documents are steadily available electronically.

#### Basic Education

<table>
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<tr>
<th>Number</th>
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<tr>
<td>557-0412-01L</td>
<td>Dance I</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>C. König</td>
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</table>

**Abstract**

**Objective**

**Content**

**Lecture notes**
During the semester the documents are steadily available electronically.

<table>
<thead>
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<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>557-0433-00L</td>
<td>Apparatus Gymnastics and Trampoline I</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>B. Mattli Baur, M. M. Jaeggi</td>
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</table>

**Abstract**

**Objective**

**Content**

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<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Semester</th>
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<td>Basketball - Basics</td>
<td>2</td>
<td>W</td>
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<td>Prerequisites: Practical course Movement Sciences I-III (BSc HMS) or Assessment III (BSc HST).</td>
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<td>557-0533-01L</td>
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<td>Compulsory for Sport Teaching Diploma, new Programme Regulations.</td>
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**557-0503-01L Basketball - Basics**

Abstract
Basics of basketball include basic technical skills: shooting, passing, dribbling, related to specific basketball rules. Pre-/tactical skills up to level 3 vs. 3. With these learnings, the game 5 vs. 5 can be played, although it is not a primary topic of this event.

Objective
Basics of basketball technical and tactical skills related to specific basketball rules. Tactical skills: from 1:0 through 3:3, preparing 5:5.

Content
Basic technical skills: shooting, passing, dribbling, related to specific basketball rules.

Lecture notes
No specific script.

**557-0514-03L Soccer I**

Abstract
Support and development of individual conditions/fitness/skill and introduction of basic methods will be treated.

Objective
Support and development of individual conditions/fitness/skill and introduction of basic methods want to be at the centre of attention.

Content
Technique: dribble, short passing, play, get the ball under control, shot, individual tactics: offensive/defensive, 1 vs 1; keep ball in own rows.

**557-0533-01L Floorball I**

Abstract
Experiencing unihockey/floorball as an indoor sport game.

Objective
Practising unihockey to improve personal sport skills and widening personal abilities in ball sports.

Content
Transfer of ideas into motor movements and motor skills.

**557-0603-00L Snowsport I**

Abstract
Snowsport I (BSc HST) passed.

Objective
Practising unihockey to improve personal sport skills and widening personal abilities in ball sports.

Content
Training of personal sport skills in ball games.

Literature
Classes are based on insights from the book "Unihockey Basics" by B. Beutler, M. Wolf.

Prerequisites / notice
Please bring your personal hockey stick with you to class.

Prerequisites:
- Trampolinschule nach der Part-Methode, BASPO 2013

Basketball - Basics: Basic technical skills: shooting, passing, dribbling / ball handling, related to specific basketball rules.

(Pre-)tactical skills: from 1:0 through 3:3, preparing 5:5


Manual for monitors of the Swiss Youth & Sports program (available through the "Jugend & Sport" office, German / French / Italian)

Basektball. Fundamental skills for offensive play. Video (German / French). Magglingen, BASPO, 2003 (CHF 34.-). Order at video@baspo.admin.ch

Prerequisites:
- Bucher, Walter (Hrsg.) 1020 Spiel- und Übungsformen im Kinderfussball, 7. unveränderte Auflage 2011, Hofmann-Verlag, Schorndorf

Prerequisites / notice
1. Prerequisites: Small being able in soccer.
   Readiness to train.
2. After this course you can get the license "manager for children".

Prerequisites: Only 1 absence from the lessons "football for children", the book "Kinderfussball" can be bought in the course

Prerequisites:
- Please bring your personal hockey stick with you to class.

Snowsport I (BSc HST) passed.

Prerequisites:
- Assessment I+II (BSc HST) passed.
**Abstract**
Education in the disciplines of winter sports (ski or snowboard)

**Objective**
The students:
- experience the different winter sports
- gain an understanding of how to ski off-piste

**Content**
To apply and vary personal technique of alpine skiing
To apply and vary personal technique of snowboarding
To acquire and vary personal technique of cross-country skiing
Competition in ski-jumping, and giant slalom
To gain an understanding in how to ski off-piste

**Prerequisites / notice**
Requirement: Assessment I + II (BSc HST)

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<tr>
<td>557-0609-00L</td>
<td>Trendsports</td>
<td>W</td>
<td>2</td>
<td>R. Scharpf, O. Graf</td>
</tr>
</tbody>
</table>

**Prerequisites:** Assessment II passed (BSc HST) or enrolled in Teaching Diploma Sport.

**Abstract**
Compulsory for students of Teaching Diploma Sport on in the new Programme Regulations.

**Objective**
The students learn basic skills of a wide range of well-known and new sports

**Content**
Introduction of new and established sports like Badminton, Flagball, Touch, contact games, Icehockey, a.s.o.

**Lecture notes**
Information is provided on Moodle.

**Prerequisites / notice**
Students need to be inscribed in LD Sport or must have passed assessment II.

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<tr>
<td>557-0522-01L</td>
<td>Handball I</td>
<td>W</td>
<td>2</td>
<td>O. Buholzer</td>
</tr>
</tbody>
</table>

**Prerequisites:** Practical course Movement Sciences III (BSc HMS) or Assessment III (BSc HST).

**Abstract**
Compulsory for students of Teaching Diploma Sport on in the new Programme Regulations.

**Objective**
The students improve their personal skills and demonstrate the game in teams as well as groups of 4 against 4.

**Content**
Spielend Handball lernen - Über das Spiel zum Spiel (Vom Spiel 3/3 zum Spiel 4/4)
Techniktraining ist Sache der Studierenden.
Die individuelle Grundschulung wird mit Lernkontrollen überprüft (Kontrollblätter).
Alle ausgewählten Formen müssen als Lernkontrolle durchführbar sein.

**Lecture notes**
Lehrunterlagen können von der Homepage abgerufen werden.

**Literature**
* Obligatorisch Spielerziehung O. Buholzer SHV Kosten Fr. 15.
* Obligatorisch Spielend Handball lernen A. Emrich Limpert Kosten Fr. 20.
* Freiwillig Spielen lernen M. Ochsenbein O. Buholzer SHV Kosten Fr. 15.
* Freiwillig Technik lernen O. Buholzer SHV
Muss selbständig erworben oder bei Semesterbeginn bestellt werden.

**Prerequisites / notice**
Testatbedingungen Präsenz:
Maximale Abwesenheiten (3 entschuldigte und 3 unentschuldigte Absenzen) Testatübungen: Im Rahmen der Ausbildung werden Zonenspiele und Fertigkeiten erarbeitet. Für das Testat (Bewegungswissenschaftler) müssen insgesamt 6 Testatübungen aus mind. 4 praktischen Bereichen abgegeben werden.

Prüfungen Inhalte: Die Prüfungsinhalte werden während des Semesters erarbeitet und am Ende des Semesters schriftlich abgegeben.

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<tr>
<td>557-0601-00L</td>
<td>Badminton I</td>
<td>W</td>
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<td>P. Lüscher Luchsinger</td>
</tr>
</tbody>
</table>

**Prerequisites:** Assessment III (BSc HST).

**Abstract**
Compulsory for students of Teaching Diploma Sport on in the new Programme Regulations.

**Objective**
To learn and to deepen technical and tactical abilities and skills of the game; to show methodical learning- and structural series

**Content**
To learn all the basic strokes
to learn the basic foot work
to get to know single and double tactics
to try out different game variations

**Lecture notes**
Die Skriptunterlagen können auf moodle heruntergeladen werden

**Literature**
Lehrunterlagen von Shuttle Time
### Major Education

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>
| 557-0516-03L | Soccer II  
Prerequisites: Basic course completed | W    | 2    | 2G    | P. C. Humbel, H. A. Russheim |
|            | **Abstract** |  
Acquisition/consolidation basic skills for the soccer.  
Support and development the individual conditions/talent/skill and introduction of basic methods will be treated. |  
**Objective** |  
Acquisition/consolidation skills in soccer basics.  
Support and development the individual conditions/talent/skill and introduction of basic methods will be treated. |  
**Content** |  
Dribble, pass the ball, get the ball under control, shot, throw-in, header  
Individual tactics: offensive/defensive 1vs1/ 2vs1 / 2vs2 / 3vs3; keep ball in own rows  
various contests in support of different techniques and tactics |  
**Literature** |  
- J+S Ordner Fussball |  
**Prerequisites / notice** |  
1. This course is leaded from Peter Humbel and Heinz Russheim together. For questions address Peter Humbel. |
| 557-0555-00L | Basketball II  
Prerequisite: Basic course completed | W    | 2    | 2G    | R. Maggi |
|            | **Abstract** |  
Further development of the technical skills. Structural development of defensive behavior appropriate to the game situation. Introduction to the pre-tactical element of the pick away. Additionally the role and use of the inside players on offense and defense is looked at. In the center of attention during games stands the game management the combination of roles - teacher/coach/referee. |  
**Objective** |  
Further training of the individual basketball skills  
- Participants know the tactical and technical aspects of the pick away  
- Participants can make the right decisions in various defensive situations and with that make it more difficult for the offense.  
- Leadership of a team during the game and during physical education class |  
**Content** |  
- Individual basics Passing/Footwork/Dribbling/Shooting  
- Basics in the man-to-man defense on ball/off ball/stop the cut  
- Basics on offense getting open/cutting/scoring  
- Movement of the inside players  
- pick away  
- Game management in the classroom combination of roles teacher/coach/referee |  
**Literature** |  
- HAGENDORN, NIEDLICH, SCHMIDT: Basketball-Handbuch, rororo 1985 - Script VF Basketball, aktuell |  
| 557-0545-00L | Volleyball II  
Prerequisite: Basic course completed | W    | 2    | 2G    | M. Attinger |
|            | **Abstract** |  
To learn the game of volleyball through the interaction between individual playing positions. To achieve skills in a six-a-side game without specialization. (system 3-2-1, setter pos. 1) |  
**Objective** |  
To know the chain of action for each players position in the game  
To be able to play volleyball 6 against 6 without specialization (system 3-2-1-, setter position 1) |  
**Content** |  
- basics, especially setting, block-defense  
- individual tactics: chain of action, attack in all 3 net positions, setting from position 1, statistical evaluation of the game  
- methodical steps: training of training session, including adaptation for stronger and weaker players, individual corrections for players |  
**Literature** |  
- PAPAGEORGIOU/CZIMEK: "Volleyball Spielerisch Lernen"  
- PAPAGEORGIOU/SPITZLEY: "Volleyball Grundlagenausbildung"  
- PAPAGEORGIOU/SPITZLEY "Leistungsvolleyball"  
- PAOLINI M.: "Volleyball from young player to champions"  
- MEYNDT/BEUTELSTAHL: "Richtig Volleyball - Halle und Beach" |  
| 557-0605-00L | Snowsport II  
Prerequisite: Basic education Snowsport I completed. | W    | 2    | 2G    | P. Disler, further lecturers |
|            | **Abstract** |  
Only for students in Human Movement Sciences and Health Sciences and Technology.  
Specialization training: Acquisitions of special skills, getting to know the performance factors and training methods in the areas of Snowsports. |  
**Objective** |  
- To deepen and expand experience and skills in snow sports and in the personal competency of technique of the chosen snow sport.  
- To expand skills to the area of telemark and competition |  
**Content** |  
- To acquire knowledge and experience in planning and realization of back-country skiing and consider the environment  
- Telemark or competition as an extra experience in the framework of technique. |  
**Literature** |  
- PAPAGEORGIOU/CZIMEK: "Volleyball Spielerisch Lernen"  
- PAPAGEORGIOU/SPITZLEY: "Volleyball Grundlagenausbildung"  
- PAPAGEORGIOU/SPITZLEY "Leistungsvolleyball"  
- PAOLINI M.: "Volleyball from young player to champions"  
- MEYNDT/BEUTELSTAHL: "Richtig Volleyball - Halle und Beach" |  
**Prerequisites / notice** |  
Requirement: Basic course in Snowsport I completed. |
Fitness II

Prerequisites: successful completion of Basic Education in Fitness.

Abstract
A consolidation of fitness education; relevant performance factors in the training of physical fitness. Acquisition of skills, methodology in fitness coaching and the area of group fitness. Getting to know current and prophylactic training aspects and the training thereof.

Objective
A consolidation of fitness education; relevant performance factors in the training of physical fitness. Acquisition of skills, methodology in fitness coaching and the area of group fitness. Getting to know current and prophylactic training aspects and the training thereof.

Content
- Anamnese und Trainingsplanung
- Trainingsmittel im Fitnessbereich
- Methoden im Kraft und Ausdauerbereich
- Einführung von Personen an Fitnessgeräten, Instruktion und Korrektur
- Funktionelle Anatomiekennnisse im Fitnessbereich
- Sicherheits- und Trainingsregeln im Group Fitness
- verbales & visuelles Cuering
- Funktionelles Training im Group Fitness
- Training der Tiefenmuskulatur ohne/mit instabiler Unterlage
- Intervaltraining als Stundenformat
- Koordinationstraining ohne/mit Hilfsmittel
- Dehnmethoden
- Zielgruppenangepasste Stundenformate

Lecture notes
Wird im Unterricht abgegeben oder auf Moodle bereitgestellt

Literature
- Skript und Unterlagen Fitness I
- Training fundiert erklärt, J. Hegner, 5. Auflage 2012
- Der neue Muskelguide, F. Delavier, 13. Auflage 2011
- Core Performance, M. Verstegen, 8. Auflage 2010
- Taschenatlas Anatomie: Bewegungsapparat, von W. Platzer, 11. Auflage 2013

Prerequisites / notice
Prüfungsanforderungen
Fitnessberatung: Training und Einführung an Fitnessgeräten, Fragen über Inhalte des Fitness-Vorlesungsskripts beantworten
Group Fitness: Fragen über Inhalte des Group Fitness-Vorlesungsskripts und Praxissequenzen beantworten, Präsentation eines Trends (schriftliche Arbeit und Präsentation), Unterrichten einer Kleingruppe (vorgegebene Sequenz)

Acrobatics II

Prerequisites: successful completion of Basic Education.

Abstract
To get to know and understand the basics of movement (core movements) and its respective actions and functions on the floor, in acrobatics and partner acrobatics as well as in Parkour to create individual and cooperative combinations according to qualitative criteria.

Objective
The students should be able to:
- acquire and consolidate core movements as well as to apply and create such combinations
- utilize their own strength as well as the resulting impact in a differentiate way in order to precisely and economically move the swinging, flying, falling and twisting body
- gain orientation safety and room orientation while twisting and flying
- gain sensitivity for social competences (e.g. to assist, to observe, to advise) within a small group
- compose and present within a group of three a creative performance

Content
- Freerunning
- creative and cooperative composition in a threesome accompanied by music
- core movements and combinations on the floor, the tumbining-track (airtrack) and the wall
- vault springs and touching down springs (stuetz springs) to overcome obstacles in a artful way
- methodical didactical inputs

Education Acquired Outside ETH

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
557-0450-00L | Life Saving Rescue Test Plus Pool SLRG | O | 2 credits | external organisers

Confirmation of course attendance Brevet Basis Pool and Brevet Plus Pool SLRG.

External education! Credit points only for Sport Teaching Diploma!

Abstract
Acquirement of the livesaving rescue test I SLRG. More details: www.slr.ch

Objective
To recognize danger in, on and around water
Knowledge and handling of life saving equipment
Rescue and towing techniques
Orientation under water
To rescue a person
Basis knowledge in anatomy and first aid

557-0451-00L | Samariterausweis | O | 2 credits | external organisers

Confirmation of course attendance “Samariterausweis”.
More information: www.samariter.ch.

External education! Credit points only for Sport Teaching Diploma!

Abstract
Inhaltliche Schwerpunkte der Vorlesung sind:

Additional Requirements in Sports Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0203-00L</td>
<td>Movement and Sport Biomechanics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Taylor, R. List, S. Lorenzetti</td>
</tr>
<tr>
<td>376-0207-00L</td>
<td>Exercise Physiology</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>C. Spengler</td>
</tr>
<tr>
<td>376-1033-00L</td>
<td>History of Sports</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Gisler</td>
</tr>
<tr>
<td>376-1107-00L</td>
<td>Sport Pedagogy</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>D. Seiler Hubler</td>
</tr>
<tr>
<td>376-1117-00L</td>
<td>Sport Psychology</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>H. Gubelmann</td>
</tr>
</tbody>
</table>

Literature

Recommended textbooks:

Prerequisites / notice
- Fremdausbildung; Dauer 7x2h
This lecture is intended as an introduction to sport psychology and imparts knowledge on selected aspects of the subject.

**Objective**

Students are given insight into different work areas of sport psychology. In order to understand what »sport psychology« is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students' expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

**Content**

Main Topics
- Introduction to sport psychology
- Cognitions in sports: mental rehearsal and mental training
- Emotions and stress
- Motivation: goal-setting in sports
- Career and career transition in elite sport
- Coach-Athlete-Interaction
- Psychological aspects of sport-injury rehabilitation
- Group dynamics in sport

**Literature**


**Lecture notes**

Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

**376-1127-00L** Sociology of Sport  
**W** 2 credits  
**M. Lamprecht**

**Abstract**

These lectures deal with the current changes in society and sport and provide an overview of the different main problems and perspectives of sport sociology.

**Objective**

The lectures set out to:
- present the different dimensions, functions and interrelationships of present-day sport
- provide an introduction to the central theories and models of (sport) sociology
- show how far sport reflects society and how it changes and becomes more differentiated in the process
- take current examples from newspapers, magazines and television to highlight the sociological view of sport.

**Content**

Sport and social change: developments and trends
The economy and the media: dependencies, consequences, scandals
Social inequalities and distinctions: gender differences and group behavior
Conflicts and politics: sports organizations, doping, violence

**Lecture notes**

Selected materials for the lecture are available under www.LSSFB.ch --> Lehre

**376-0130-00L** Laboratory Course in Exercise Physiology  
**W** 3 credits  
**C. Spengler**

**Number of participants limited to 48.**

**Abstract**

Conduct physical performance tests and measurements that are typically used to assess performance of athletes and patients and that deepen the understanding of physiological processes in response to physical exertion.

**Objective**

Gain hands-on experience in exercise physiology and consolidate knowledge on physiological adaptations to different types and degrees of physical activity and climatic influences. Learn fundamental assessment techniques of the muscular system, the cardio-respiratory system and of whole-body performance, learn scientifically correct data analysis and interpretation of results. Insight into today's Sports Medicine.

**Content**

Laboratory course:
- Various exercise tests assessing human performance and assessments of physiological responses to activity (examples are VO2max-test, Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test), dynamometry, mechanography, body composition etc.). Insight into measurements in Sports Medicine.

**Literature**

Schmidt/Lang/Heckmann: Physiologie des Menschen, Springer-Verlag, Heidelberg

**Prerequisites / notice**

Anatomy and physiology classes and lab course in physiology successfully completed (BWS students please contact C. M. Spengler)

**Desirable:**
Exercise Physiology Lecture (concomitantly or passed; is selection criterion in case of more applications than lab spaces)

**376-1665-00L** Training and Coaching  
**W** 3 credits  
**O. Buholzer**

**Abstract**

The combining of training and coaching as in the example of sport analysis, which has an effect on youth training and athlete development
- To develop basics for a differentiated analyses of sports (model)
- To develop a profile of requirements for specific sports
- To develop competencies of training with youth and talents
- To develop the basics of talent training in theory and practice
- To observe athletes in case studies, make judgments and conclusion

**Objective**

Das Modell der Sportartenanalyse
Die Relevanz der einzelnen Leistungsfaktoren
Das Modell der Wettkampfanalyse
Folgerungen für das Training und Coaching in der Sportart
Folgerungen für das Nachwuchstraining
Folgerungen für die Athletenauswahl, Athletenbeobachtung und -betreuung
Das Nachwuchs- und Talenteinrichtung (Sichtung, Selektion, Förderung)
Projekte aus der Praxis (Talent- und Nachwuchsretraining
Praxisinput zum Thema Koordination, motorische Grundbedürfnisse, Kraft und Gesundheit
Praxisbeispiele erarbeiten und planen
Konkrete Athletenbeobachtung
Lecture notes

Die Skript- (Lektionsunterlagen) werden im Rahmen des Semesters abgeben und auf Homepage veröffentlicht.

Leistungsdiagnostische Verfahren, Stiehler(Konzag/Döbler)

Training fundiert erklärt, Handbuch der Trainingslehre, Ingold Verlag 2006


Das sportliche Talent, W. Joch, Meyer&Meyer Verlag, 2002

Prerequisites / notice

Für die Kreditvergabe sind die vorgeschriebenen Semesterarbeiten und die Präsenz zwingend. Die Benotung erfolgt durch eine schriftliche Arbeit.

Planung

Die Planungsunterlagen werden zu Semesterbeginn abgegeben, sind provisorisch und können vom Dozenten geändert werden. Die Praxislektionen werden jeweils am Mittwoch von 13.00 - 15.00 abgehalten. Die Termine werden in Absprache festgelegt.

Die Semesterarbeit ist 4 Wochen nach Semesterende abzugeben.


Abstract

Based on practical examples out of sport, everyday movement and therapy, students use and compare different methods of movement analysis.

Objective

Students are able to assess human movement using different methods of movement analysis.

Content

During the course students get acquainted with different methods of movement analysis such as: functional, morphological, clinical, mechanical, and others. Based on practical examples, these methods are used and compared. The examples range from sport, everyday movement and therapy, such as hockey, gymnastics, acrobatics, badminton, gait / running and strength training. In the first phase of the class, the different approaches are applied. In the second phase, small teams are working on individual projects. These will be discussed and presented in plenum.

Lecture notes

Class material will be distributed using the moodle platform.

Sport Teaching Diploma - Key for Type

| W+ | Eligible for credits and recommended | E- | Recommended, not eligible for credits |
| W  | Eligible for credits               | Z  | Courses outside the curriculum       |
| O  | Compulsory                        | Dr | Suitable for doctorate              |

Key for Hours

| V  | lecture                           | P  | practical/laboratory course         |
| G  | lecture with exercise             | A  | independent project                 |
| U  | exercise                          | D  | diploma thesis                      |
| S  | seminar                          | R  | revision course / private study      |
| K  | colloquium                        |

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Public Policy Bachelor

### 1. Semester

#### Core Courses First Year Examinations

##### Examination Block 1

**Students are free to take the exam either in German or in French. They may choose between 853-0723-00L 'Introduction to Torts, Contract and Insurance Law' or 851-0709-00L 'Introduction to Civil Law' (French)**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0723-00L</td>
<td>Introduction to Torts, Contracts and Insurance Law</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>C. von Zedwitz</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to Torts, Contracts and Insurance Law.</td>
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</tr>
<tr>
<td>Objective</td>
<td>The course shall make sure that the participants are fit to make the adequate decisions when encountering legal issues and questions in their career.</td>
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<tr>
<td>Content</td>
<td>The course touches upon relevant topics of Contract Law (formation of contract and contract performance), Tort Law (including liability limitation), corporate law (types of corporations, formation of LLC), civil procedure (jurisdiction and applicable law, costs, when and how to engage a lawyer) and insurance law (duty to disclose relevant facts, gross negligence).</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course 'Introduction au Droit civil' (851-0709-00) provides an introduction to the law of Contracts and Torts in French.</td>
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<tr>
<td>851-0709-00L</td>
<td>Introduction to Civil Law</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>H. Peter</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course Private Law focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In addition, the course will provide a short overview of Civil Procedure and Enforcement.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Enseignement des principes du droit, en particulier du droit privé. Introduction au droit.</td>
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<tr>
<td>Content</td>
<td>Le cours de droit civil porte notamment sur le droit des obligations (droit des conséquences et responsabilité civile) et sur les droits réels (propriété, gages et servitudes). De plus, il est donné un bref aperçu du droit de la procédure et de l'exécution forcée.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Editions officielles récentes des lois fédérales, en langue française (Code civil et Code des obligations) ou italienne (Codice civile e Codice delle obbligazioni), disponibles auprès de la plupart des librairies.</td>
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</tbody>
</table>
| Prerequisites / notice | - Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours "Recht I" et "Recht II" en langue allemande et des exercices y relatifs.  
- Les examens peuvent se faire en français ou en italien.  
- Examen au 1er prophecyce; convient pour travail de semestre. |      |      |       |                            |
| 851-0577-00L | Principles of Political Science                                      | O    | 4    | 2V+1U | S. Mohrenberg, Q. Nguyen   |
| Abstract     | This course covers the basic questions, concepts, theories, methods, and empirical findings of political science. |      |      |       |                            |
| Objective    | This course covers the basic questions, concepts, theories, methods, and empirical findings of political science. |      |      |       |                            |
| Literature   | "Politikwissenschaft: Grundlagen" by Thomas Bernauer, Patrick Kuhn, Stefanie Walter and Detlef Jahn (Nomos, 2015, 3rd Edition). |      |      |       |                            |
| Prerequisites / notice | - Politikwissenschaft: Grundlagen" by Thomas Bernauer, Patrick Kuhn, Stefanie Walter and Detlef Jahn (Nomos, 2015, 3rd Edition). |      |      |       |                            |
| 853-0033-00L | Leadership I                                                          | O    | 3    | 2V    | F. Kernic                 |
| Abstract     | The lectures "Leadership I" (WS) and "Leadership II" (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. "Leadership I" covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership. |      |      |       |                            |
| Objective    | The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations. |      |      |       |                            |
| Prerequisites / notice | The 1-hour written exam will take place during the last lecture in the semester. |      |      |       |                            |

### Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>351-1034-00L</td>
<td>Microeconomics</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>A. Fetz, M. Gysler</td>
</tr>
</tbody>
</table>

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1384 of 1571
Objective: Understanding of basic microeconomic models. Ability to apply these models to real world economic situations.

Content: Economics as a science, division of labour and welfare (concept of comparative advantage), supply and demand (market equilibrium, elasticity), households (preferences, demand, firms (technology, cost analysis, profit maximisation, supply), perfect competition, monopoly and oligopoly, externalities, public goods, information, factor markets and income distribution

Lecture notes via email


Prerequisites / notice: Course macroeconomics in the summer term

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**853-0725-00L** History Part One: Europe (The Cradle of Modernity, Britain ca. 1789-1939)

**Abstract:** Using the concrete example of Britain, the "cradle of modernity", this lecture offers a survey and analysis of the crucial historical transformations that engendered "modernity" in Europe from the late 18th to the mid 20th centuries.

**Objective:** At the end of this lecture course, students can: (a) highlight the most important changes in the "long nineteenth century" in Europe (b) explain their long-term effects; and (c) relate these changes to global developments.

**Content:** The thematic foci include: the economic and social consequences of the industrial revolution, the genesis of political ideologies and social movements, shifts in gender roles, colonialism and imperialism, as well as the emergence of consumerism and a "leisure society."

**Lecture notes:** Power Point Slides and sources will be made available at POLYBOX in the course of the semester.

**Literature:** Mandatory and further reading will be listed on course plan that is made available before the first session.

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**853-0037-00L** Military Psychology and Pedagogy I

**Only for Public Policy BA**

**Abstract:** Examine the fundamentals of the two sciences and establish links with military life. Discuss various schools of thought in psychology and focus on content and process theories of motivation. Explore characteristics of pedagogical thinking and discuss the values of military education with reference to the young adult serving in the armed forces.

**Objective:** - Becoming acquainted with basic psychological views of human behaviour and experience
- Knowing content- and process theories of motivation and being able to transfer them to the military context
- Knowing the possibilities and limitations of military education and deriving consequences

**Content:** Overall, the objective is to become acquainted with the basics of both scientific areas and to make references to military practice. Military psychology is a branch of applied psychology; consequently selected aspects of psychological principles will be covered. Military pedagogy hasn't yet established itself firmly as an independent scientific discipline, it nevertheless can draw on a deep-seated tradition in Switzerland. Thus, the great importance that has been attached to the discussion of education in Swiss society and academia will be taken into account. Subjects:
- History of military psychology
- Psychological images of humanity (psychoanalysis, behaviourism, behavioural biology, humanistic psychology, cognitivism)
- Motivational theories
- Defence-, service-, operational- and combat motivation
- Swiss military pedagogy
- Education as defining feature of pedagogical thinking and acting

**Literature:** This course is completely by a compulsory one week course between terms.

- Annen, H., Steiger, R. & Zwiggert, U.: Gemeinsam zum Ziel, Huber, Frauenfeld 2004 (provided as pdf)
- Stadelmann, J.: Führung unter Belastung, Huber, Frauenfeld 1998 (provided as pdf)

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**Remaining Core Courses of the Bachelor Programme**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0205-00L</td>
<td>Proseminar I: Political Methodology</td>
<td>O</td>
<td>3</td>
<td>2S</td>
<td>R. Huber</td>
</tr>
</tbody>
</table>
| **Abstract** | Teaching of formal requirements of scientific work (philosophy of science with a focus on the social sciences); literature reviews and the basics of conducting independent research on short as well as simple topics: basics of conceptualizing research designs for politically relevant questions and hypotheses.
| **Objective** | 1) Understanding the goal and the basic procedures of (empirical social sciences) scientific work (philosophy of science, theory building, research design, as well as the correct employment of sources, data and literature).  
2) Identification of relevant research questions.  
3) Creating a common basis for a thorough and systematic analysis of these.  
| **Content** | Political Methodology I seeks to introduce students to the basics of scientific work and procedures in the social sciences, which in turn shall allow them - also in conjunction with Political Methodology II - to conduct work that fulfills satisfactory standards of research quality throughout their further studies.  
With regard to Political Methodology I, this seminar primarily focuses on the philosophy and theory of (empirical) social sciences, its structure, and procedures. The seminar emphasizes substantive contents and ways of presenting them, research and, conceptual work. Additonally, it deals with the basis of establishing research designs with politically relevant questions and hypotheses.  
| **Prerequisites / notice** | Each student will be graded by two exercises (50% each).  
1) Source analysis and acquisition: based upon a research question that will be given by the lecturer, the student shall collect a comprehensive list of the relevant literature and summarize that with her/his own words.  
2) Critical analysis of sources: based upon a research article that the student chooses on her/his own, the student shall write a critical analysis of that, which mirrors frame and structure of scientific writing  
Submission dates will be communicated in the first meeting.  
| 853-0064-00L | Military Sociology I | O    | 3    | 2V    | T. Szvircsév Tresch |
Beside of the most important terms of sociology, demographic changes and the related value and structure change will be analysed. The second part focuses on organizational sociology. Thirdly, the course examines to which extent armed forces can be considered as organizations like any other and to which extent they constitute a special case from an organizational and normative point of view.

Objective
Recognize and explain current changes (social change) in modern society (individualisation, pluralisation); describe demographic changes in Switzerland; explain the structures of societies; define issues and fields of research in modern military sociology and explain the foundations of organisational sociology; explain the military in terms of organisational sociology and identify specific traits of the military as an organisation.

Content
Societal change; organizations as societal phenomena; aims, structures, environments of organizations; specifics of the military as an organization; impacts of technological and societal changes on the armed forces in modern societies.

Literature
A reader with a set of texts will be handed out.

Languages

First Foreign Language

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0405-00L</td>
<td>English, Part I</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>O. Gwerder</td>
</tr>
</tbody>
</table>

Abstract
Teaching is focused on the acquisition of general English in the four classical skills, i.e. speaking, listening comprehension, reading comprehension and writing. The goal is to reach level B2 or C1 depending on the linguistic proficiency of the students.

Objective
This three-semester English course should enable the participants to successfully use the English language in an international military setting.

Content
Read, analyse and write military and civilian documents
Listening comprehension using current radio or TV reports
Practise speaking through group discussions and short presentations
Systematic revision and extension of key grammar points
Systematic acquisition of general and military vocabulary

3. Semester

Remaining Core Courses of the Bachelor Programme

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0015-00L</td>
<td>Conflict Research I: Causes of War in Historical Context</td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>S. Rüegger, G. Schvitz</td>
</tr>
</tbody>
</table>

Abstract
This course offers an introduction to research on causes of wars. War as a social phenomenon is covered from the pre-state world to today's state system after the end of the Cold War. Topics include state formation and collapse, nationalism, decolonization, democracy, and ethnic conflict. Exercises complete the Lectures.

Objective
Developing an understanding for causes of war and their development over the last 500 years. Knowledge of fundamental concepts in research on causes of war.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>853-0046-00L</td>
<td>Social Psychology of Groups</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>T. Heilmann</td>
</tr>
</tbody>
</table>

Abstract
Relevant applied social psychological topics will be discussed.

Objective
1. To learn about basic fields of social psychology.
2. To apply the lessons learned to your own (military) situation/daily life.
3. To think about daily social psychological pitfalls
4. To connect theory and application based on case studies.

Content
You will work on the following topics:
1. Social perception: How do we perceive humans? And how do we do attributions of human behavior?
2. Social Cognition: Why and on what basis do we make social judgments?
4. Group psychology: What is a group? What happens if someone enters into a group? How do groups develop? What are the processes?
5. Prejudice in groups: What can we do about prejudice and conflicts between groups?
6. Applied social psychology: Insights in leadership psychology.

Literature

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0047-00L</td>
<td>World Politics Since 1945: The History of International Relations</td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>A. Wenger</td>
</tr>
</tbody>
</table>

Abstract
This lecture series provides students with an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.

Objective
By the end of the semester, participants should have a solid knowledge of the history and theoretical foundations of International Relations since the end of the Second World War.

Content
cf. "Diploma Supplement"

Literature
The lecture outlines the development of the armed forces (assets regarding manpower, technology and armament), the concepts of warfare and the actual warfare in the 19th and 20th century.

Based on the "Military Revolution" approach, the lecture examines the structural changes regarding the armed forces and the development of warfare from the 18th to the 20th century. Special emphasis will be put on how the battlefield was revolutionized due to the Napoleonic wars, the industrialization in the 19th century, the First World War, the mechanization and totalization during the Second World War and the period of the Cold War.

The lecture is structured along the lines of the concept of "Military Revolution" and starts with the formation of modern, European armed forces after the Oranian Army reform in the 17th century. Based on the "Military Revolution" approach, the lecture examines the structural changes regarding the armed forces and the development of warfare from the 18th to the 20th century. Special emphasis will be put on how the battlefield was revolutionized due to the Napoleonic wars, the industrialization in the 19th century, the First World War, the mechanization and totalization during the Second World War and the period of the Cold War.

Only for Public Policy BA


The two-term lecture series treats classic texts of strategic studies from antiquity to the present. Term 1 covers the theories up until roughly 1900, term 2 the theories ever since. Theories are deemed classic if they were prominent in their respective times and if they had a strong reception after, be it in literature, in academic debates or as guidelines for action. Each out of some 50 theories is discussed in three steps: historical context, core messages and reception.

Lecture notes

Slides as well as a textbook with primary sources and a list of further reading are accessible electronically. The textbook is also available in hard copy.

Prerequisites /


Notice

The lecture is held in German. Passive knowledge of English and French are required.
This three-semester English course should enable the participants to successfully use the English language in an international military setting. Participants are expected to study the compulsory texts provided at the beginning of the semester via the online platform Moodle. Participants should gain a solid understanding of security challenges stemming from the use and control of dual-use technologies. In addition, the students should become aware of how researchers can deal with sensitive knowledge regarding research transparency and control. Moreover, the students should develop an awareness of how researchers can deal with research transparency and control. The course will also cover various policies - in particular arms control - that are discussed and applied by the international community in dealing with such dual-use technologies.

**Prerequisites / notice**

The course requires prior knowledge of basic English grammar and vocabulary. Participants are expected to study the compulsory texts provided at the beginning of the semester via the online platform Moodle.

**Language**

**First Foreign Language**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0416-00L</td>
<td>English, Part III (only for Public Policy BA)</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>O. Gwerder</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The knowledge and skills acquired in the second semester serve as a basis for further improvements in the areas of speaking, listening, reading and writing, which will enable students to enroll for the Cambridge exams. The goal is to reach Council of Europe (CEFR) level C1 or C2 depending on the linguistic proficiency of the students.</td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>This three-semester English course should enable the participants to successfully use the English language in an international military setting.</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
| **Content**     | - Read, analyse and write military and civilian documents  
- Listening comprehension using current radio or TV reports  
- Practise speaking with group discussions and short presentations  
- Systematic revision and extension of key grammar points  
- Systematic acquisition of general and military vocabulary |

**Literature**

- Schimmelfennig, Frank: Europäische Integration (erhältlich zu Beginn des Kurses)
- Basislektüre
- Die Leistungskontrolle findet durch eine Seminarpräsentation und einen schriftlichen Schlussstest statt.

**5. Semester**

**Remaining Core Courses of the Bachelor's Programme**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0049-00L</td>
<td>Introduction to Constitutional Law in Security Policy</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>P. Sutter</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This introduction into the constitutional elements of security policy includes questions of competences (separation of powers, federalism) and considerations on the constitutional mandates and powers of military, police and private actors - especially in the state of emergency. The legal status of individuals (members of the military forces; persons involved in security measures) is ventilated.</td>
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</tbody>
</table>
| **Objective**   | Students should:  
- know the basic terms of security law;  
- understand the actors of security policy and their position within the constitutional order;  
- know the constitutional mandate and powers of the military and the police;  
- know the elements of cooperation between military and police;  
- know the constitutional rules to deal with a state of emergency;  
- know the legal status of members of the military forces;  
- know anyone rights of judicial review of security measures. |
| **Lecture notes** | Reader with copies of the relevant literature (see below)  
https://moodle-app2.let.ethz.ch/course/view.php?id=203 |
| **Literature**  | The basic sources of the lectures are:  
- Patrick Sutter, Recht der militärischen Operationen, Sicherheit & Recht 1/2008, S. 19-32 |

**4. Semester**

**Current Issues in Security Policy**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0060-00L</td>
<td>Current Issues in Security Policy</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>A. Wenger, O. Thränert</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This course provides an overview of the security implications of so-called “dual-use” technologies, i.e. technologies that can be used for both peaceful and military aims. The course will also cover various policies - in particular arms control - that are discussed and applied by the international community in dealing with such dual-use technologies.</td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Participants should gain a solid understanding of security challenges stemming from the use and control of dual-use technologies. In addition, the students should become aware of how researchers can deal with sensitive knowledge regarding research transparency and control.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The aim of the course is to provide participants with an overview of international security politics with a special focus on dual-use technologies. Students will analyze the character of dual-use security risks and of risk-based security strategies and instruments. Thematic areas include the nuclear non-proliferation regime, biological and chemical weapons conventions, missile proliferation, the nuclear programs of Iran and North Korea, cyber and space technologies, as well as robotics and nanotechnology.</td>
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<td></td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Participants are expected to study the compulsory texts provided at the beginning of the semester via the online platform Moodle.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Literature</strong></td>
<td>A reading list will be distributed at the beginning of the semester.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>An online learning platform serves as a supplement to the course.</td>
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</tr>
</tbody>
</table>
This course analyzes the foundations and challenges of Swiss foreign policy. After reviewing the history of foreign policy conceptions since the early 20th century, we will discuss the determining factors of Swiss foreign policy and examine, together with guest speakers from the foreign ministry, current issues such as the Syria crisis, the migration challenge, terrorism, and Swiss-EU relations.

**Objective**
Students should acquire a sound understanding of Swiss foreign policy and the relevant academic and political debates associated with it.

**Content**

**Lecture notes**
Students will receive a handout of slides accompanying the lectures.

**Literature**
A reading list will be handed out at the beginning of the semester.

**Prerequisites / notice**
The course will be supported by an e-learning environment.

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**Languages**

**Second Foreign Language**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0402-00L</td>
<td>German, Part II</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>O. Gwerder</td>
</tr>
<tr>
<td></td>
<td>Only for Public Policy BA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Based on the knowledge and skills acquired during the first semester, speaking and discussion skills related to military situations are examined and put into practice. Attention is focused on issues such as instruction, qualification and career interviews.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>This two-semester German course should enable the French and Italian speaking participants to fulfill their function as professional officers also in the German language.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Read, analyse and write military and civilian documents. Listening comprehension using current radio or TV reports. Practise speaking with group discussions and short presentations. Systematic revision and extension of key grammar points. Systematic acquisition of general and military vocabulary.</td>
<td></td>
<td></td>
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</tbody>
</table>

| 853-0404-00L | French, Part II     | W    | 3    | 2G    | O. Gwerder                  |
|            | Only for Public Policy BA |      |      |       |                            |
| Abstract   | Based on the knowledge and skills acquired during the first semester, speaking and discussion skills related to military situations are examined and put into practice. Attention is focused on issues such as instruction, qualification and career interviews. |
| Objective  | This two-semester French course should enable the German speaking participants to fulfill their function as professional officers also in the French language. |
| Content    | Read, analyse and write military and civilian documents. Listening comprehension using current radio or TV reports. Practise speaking with group discussions and short presentations. Systematic revision and extension of key grammar points. Systematic acquisition of general and military vocabulary. |

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**Bachelor's Colloquium and Bachelor's Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

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**Data:** 06.11.2018 12:57  
**Autumn Semester 2016**  
Page 1389 of 1571
Central aspects of sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of sports pedagogy. Furthermore, the general and sports relevant foundations of sport related pedagogy will be covered.

Prerequisites / notice

If you have questions, please contact Lukas Meyer, lukas.meyer@sipo.gess.ethz.ch.

#### Electives

#### Recommended Elective Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-010-00L</td>
<td>Military Business Administration II - Case Examples</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>M. M. Keupp</td>
</tr>
</tbody>
</table>

The elective course Military Business Administration II builds on the mandatory course Military Business Administration I and adds to it. It deals with in-depth case studies from international security and economic policy with a special emphasis on the economic and practical relevance of these issues for the Swiss Armed Forces.

**Objective**

Students who are intrinsically interested in business-related issues will be provided with a big picture that transcends the micro view of business administration. Students learn how to integrate security and resource-related issues into a global economic analysis and how to derive relevant consequences, particularly economic ones, for Switzerland.

**Content**

The program of the course is organized into 14 units of 90 minutes each. The units combine the elements of lecture (where analytical concepts are taught) and application (where these concepts are applied). Additionally, guest lecturers will hold talks on selected issues.

* Swiss economic autarchy - madness or option?
* Global resource positions and world trade: Implications for the Swiss Armed Forces
* Global resource positions and world trade: Implications for the Swiss Armed Forces II
* Economic causes of military instability
* Aggressive emerging economies: Economic growth and rearmament
* The process of an arms deal
* Costs and financing of a military conflict
* Economic analysis of terrorism
* Economic analysis of cyberwar
* Economic analysis of the present GSQA initiative: Compulsory military service vs. voluntary militia
* Global arms production and international arms trade
* The privatisation of military security
* Standardisation and interoperability: Does NATO membership increase Swiss military efficiency
* Written exam

Lecture notes

As this course has been completely redesigned and is being offered for the first time in the fall semester of 2013, a script is not yet available. However, the lecturer will distribute all necessary course material in time and directly to the students, either in the classroom or by uploading files to a public server.

Literature

Exam "Military Business Administration I" passed successfully or profound basic knowledge of business administration and economics. The course is open to external participants.

#### Additional Elective Courses

These Electives may be chosen from the start of the Bachelor Study Programme.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1033-00L</td>
<td>History of Sports</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Gisler</td>
</tr>
</tbody>
</table>

Comprehension for development and changes of sports from the ancient world to the present. Description of sports in services of national ideas, from education and health promotion from the middle of the 18th century till this day.

**Objective**

Understanding for the development and adaptation of sports from the ancient world to present times.

**Content**


Lecture notes

Ein Skript für die aktuelle Veranstaltung wird abgegeben.

Literature


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1107-00L</td>
<td>Sport Pedagogy</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>D. Seiler Hubler</td>
</tr>
</tbody>
</table>

Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

**Objective**

To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.

**Content**

Inhaltliche Schwerpunkte der Vorlesung sind:

- Einführung in die Sportpädagogik und die pädagogische Psychologie des Sportunterrichts
- Bedeutung des Sports im Jugendalter
- Zeitgemäßer Sportunterricht
- Sport und Leistung
- Heterogenität im Sportunterricht
- Sport und Gesundheit
- Geschlechterfragen im Sport
- Soziale und moralische Entwicklung im Sportunterricht

Lecture notes

Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1117-00L</td>
<td>Sport Psychology</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>H. Gubelmann</td>
</tr>
</tbody>
</table>

This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.
Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students’ expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these into their teaching.

Main Topics
- Introduction to sport psychology
- Cognitions in sports: mental rehearsal and mental training
- Emotions and stress
- Motivation: goal-setting in sports
- Career and career transition in elite sport
- Coach-Athlete-Interaction
- Psychological aspects of sport-injury rehabilitation
- Group dynamics in sport

These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.

Objective
- present the different dimensions, functions and interrelationships of present-day sport
- provide an introduction to the central theories and models of (sport) sociology
- show how far sport reflects society and how it changes and becomes more differentiated in the process
- take current examples from newspapers, magazines and television to highlight the sociological view of sport.

Content
- Sport and social change: developments and trends
- The economy and the media: dependencies, consequences, scandals
- Social inequalities and distinctions: gender differences and group behavior
- Conflicts and politics: sports organizations, doping, violence

Selected materials for the lecture are available under www.LSSFB.ch --> Lehre

WebClass Introductory Course History of Technology

Abstract
WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to:

- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology
- improved understanding of the role of science and technology in the context of human and societal development

The course is designed to provide an introduction to the central theories and practices of the field.

Content

Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Objective


Lecture notes


Literature

https://www.tg.ethz.ch/de/programme/

Prerequisites / notice


Weitere Informationen unter https://www.tg.ethz.ch/de/programme/

WebClass Introductory Course History of Technology

Abstract

Technology change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects.

Objective

- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology
- improved understanding of the role of science and technology in the context of human and societal development

Content

Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies. The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g., environmental regulations, anti-trust law) or facilitate (e.g., intellectual property rights protection, public investment in R&D and technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.
Lecture notes

Reader with issue-specific articles. E-version is partly available under
https://www.ethz.ch/content/specialinterest/gess/cis/international-relations/en/teaching/materials/tech.html


The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester.

The class will be taught in English.

Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Hours</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0594-00L</td>
<td>International Environmental Politics</td>
<td>3</td>
<td>2V</td>
<td>Bernauer</td>
</tr>
</tbody>
</table>

Prerequisites / notice

Particularly suitable for students of D-ITET, D-USYS

Objective

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.
This course deals with fundamental and proven management concepts. The lecturers emphasize the practical applicability of concepts.

We develop a 'systemic' view of organizations.

Students:

Empfohlen werden folgende Titel für die Vertiefung einzelner Themen:

- Basic Concepts of Management

This course is an introduction to the critical management skills involved in planning, structuring, controlling and leading an organization.

The content of the course will rely on the book:


Students:

- will be familiar with basic general management concepts.
- will learn about the fundamental concepts of strategy development with practical examples.
- will get to know the basic organisational issues and the essential types of organisations.
- get a rough overview on the concepts of financial management.
- will learn about the strategic positioning of small departments within larger organisations.
- will learn about the fundamental mechanisms for handling change, and will be able to recognise these situations.
- will learn the basic principles of project management and of successful self-management.
- will reflect on customer oriented information representation.

Prerequisites / notice

- None

Lecture notes

Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <michaeahu@student.ethz.ch>). All assigned papers must be read ahead of the respective meeting. Following the course on the basis of on-line titles and papers alone is not sufficient. Physical presence in the classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GESS library at the IFW building, Haldeneggstein 4, B-floor, or in the library of D-USYS.

Literature

Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <michaeahu@student.ethz.ch>).

Course code: 701-0763-00L

Title: Basic Concepts of Management

Abstract

This course deals with fundamental and proven management concepts. The lecturers emphasize the practical applicability of concepts. The course was designed in close cooperation with practitioners; e.g. will Mr. S. Baldegger, mechanical engineer ETH, MBA Insead, share his experience in several guest lectures.

Objective

Students:

- will be familiar with basic general management concepts.
- will learn about the fundamental concepts of strategy development with practical examples.
- will get to know the basic organisational issues and the essential types of organisations.
- get a rough overview on the concepts of financial management.
- will learn about the strategic positioning of small departments within larger organisations.
- will learn about the fundamental mechanisms for handling change, and will be able to recognise these situations.
- will learn the basic principles of project management and of successful self-management.
- will reflect on customer oriented information representation.

Content


Prerequisites / notice

Deutsch

Lecture notes

Skripten werden elektronisch zur Verfügung gestellt.

http://www.timgroup.ethz.ch/teaching.html

http://www.timgroup.ethz.ch/teaching.html

Literature

Empfohlen werden folgende Titel für die Vertiefung einzelner Themen:

- Introduction to Management

This course is an introduction to the critical management skills involved in planning, structuring, controlling and leading an organization.

We develop a 'systemic' view of organizations.

We look at organizations as part of an industry context, which is affected by different elements like strategy, structure, culture, tasks, people and outputs.

We consider how managerial decisions are made in any one of these domains affect decisions in each of the others.

Further information is available on the Tim Group Chair's website:

http://www.timgroup.ethz.ch/en/courses

and on the Moodle of the course:

https://moodle-app2.let.ethz.ch/course/view.php?id=2209

(The Enrollment Key to Moodle will be provided during the course)

The content of the course will rely on the book:


Selected readings from the book and additional learning materials will be available on the course Moodle:

https://moodle-app2.let.ethz.ch/course/view.php?id=2209

All the materials uploaded on Moodle must be considered as required readings.

Prerequisites / notice

The final exam of the present course is in written form.

The final exam is requested for all types of students (BSc, MSc, MA, PhD, and Exchange students).

It is not possible to retake the exam within the same term or academic year.

We strongly recommend Exchange students to take it into consideration when selecting the courses to attend.

Course code: 363-0341-00L

Title: Introduction to Management

Abstract

This course is an introduction to the critical management skills involved in planning, structuring, controlling and leading an organization.

We develop a 'systemic' view of organizations.

We look at organizations as part of an industry context, which is affected by different elements like strategy, structure, culture, tasks, people and outputs.

We consider how managerial decisions are made in any one of these domains affect decisions in each of the others.

Content

Further information is available on the Tim Group Chair's website:

http://www.timgroup.ethz.ch/en/courses

and on the Moodle of the course:

https://moodle-app2.let.ethz.ch/course/view.php?id=2209

(The Enrollment Key to Moodle will be provided during the course)

The content of the course will rely on the book:


Selected readings from the book and additional learning materials will be available on the course Moodle:

https://moodle-app2.let.ethz.ch/course/view.php?id=2209

All the materials uploaded on Moodle must be considered as required readings.

Prerequisites / notice

The final exam of the present course is in written form.

The final exam is requested for all types of students (BSc, MSc, MA, PhD, and Exchange students).

It is not possible to retake the exam within the same term or academic year.

We strongly recommend Exchange students to take it into consideration when selecting the courses to attend.

Course code: 851-0735-10L

Title: Business Law

Particularly suitable for students of D-ITET, D-MAVT

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory.

Lecture notes

None

Lecture notes

Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <michaeahu@student.ethz.ch>). All assigned papers must be read ahead of the respective meeting. Following the course on the basis of on-line titles and papers alone is not sufficient. Physical presence in the classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GESS library at the IFW building, Haldeneggstein 4, B-floor, or in the library of D-USYS.

Literature

Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <michaeahu@student.ethz.ch>).

Prerequisites / notice

None
Abstract
The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.

Objective
The students shall obtain the following competence:
- They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise.
- They shall be familiar with the issues of corporate compliance, i.e. the system to ascertain that all legal and ethical rules are observed.
- They shall have an understanding of the law as a part of the corporate strategy and as a valuable resource of the company.

Lecture notes
A comprehensive script will be made available online on the moodle platform.

101-0515-00L Project Management
W 2 credits 2G M. Kersting

Abstract
General introduction to the development, the life cycle and the characteristics of projects. Introduction to, and experience with, the methods and tools to help with the preparation, evaluation, organisation, planning, controlling and completion of projects.

Objective
To introduce the methods and tools of project management. To impart knowledge in the areas of project organisation and structure, project planning, resource management, project controlling and on team leadership and team work.

Content
- From strategic planning to implementation (Project phases, goals, constraints, and feasibility)
- Project leadership (Leadership, Teams)
- Project organization (Structure)
- Project planning (Schedule, cost and resource planning)
- Project controlling
- Risk and Quality Management
- Project completion

Lecture notes
Yes. The transparencies will be available for download from the website at least one week before each class. Copies of all necessary documents will be distributed at appropriate times.

851-0585-15L Complexity and Global Systems Science
W 3 credits 2V D. Helbing, N. Antulov-Fantulin

Prerequisites: solid mathematical skills. Particularly suitable for students of D-ITET, D-MAVT

Abstract
This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.

Objective
Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

Content
This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at "tipping points", multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflicts, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or "tragedies of the commons" such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating technosocio-economic-environmental problems, and what data science may contribute to their solution.

Prerequisites / notice
Mathematical skills can be helpful

363-0622-00L Basic Management Skills
W 3 credits 8G R. Specht

Limited number of participants. Mandatory registration by E-Mail to: bms@ethz.ch


Abstract
With the aim of preparing the students to take on managerial responsibility, this 2x5 days-seminar teaches basic and practical management skills.

Objective
To convey management behaviour based on practical examples, own experiences and team discussions complemented by short theory sessions (subsidized from the donation for promotion and training in enterprise sciences at the ETHZ).

Content
1 Fundamentals of Communication Psychology
2 Communication in Business-Life
3 Fundamentals of Leadership
4 Self-Management and Life Balance
5 Leadership Tools
6 Problem Solving and Decision Making Techniques
7 Performance Coaching
8 Conflict Management
9 Personality
10 Summary-Day, Domino-Examination

Lecture notes
Will be provided as electronic version at www.entrepreneurship.ethz.ch at least one week before the seminar starts.
Prerequisites / notice

Special permission from lecturers required
Limited number of participants: Mandatory registration required.

IMPORTANT NOTICE

Preliminary announcement: Seminar 2 is offered in Spring Semester 2017. Students can only register and participate in "Seminar 1" OR "Seminar 2".

Seminar 1: 2 x 5 days
Limited number of participants: Mandatory registration required for "Seminar 1" until 30.06.2016 by E-Mail: bms@ethz.ch
Block I: 15.-19.08.2016, 9-17 h
Block II: 05.-09.09.2016, 9-17 h
where: tba

Seminar 2: 2 x 5 days
Limited number of participants: Mandatory registration required for "Seminar 2" until 26.09.2016 by E-Mail: bms@ethz.ch
Block I: 30.01.-03.02.2017, 9-17 h
Block II: 13.02.-17.02.2017, 9-17 h
where: tba

751-1551-00L Ressourcen- und Umweltökonomie W 3 credits 2V L. Bretschger, A. Müller

Abstract
Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

Objective
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
Introduction to resource and environmental economics
Importance of resource and environmental economics
Main issues of resource and environmental economics
Normative basis
Utilitarianism
Fairness according to Rawls
Economic growth and environment
Externalities in the environmental sphere
Governmental internalisation of externalities
Private internalisation of externalities: the Coase theorem
Free rider problem and public goods
Types of public policy
Efficient level of pollution
Tax vs. permits
Command and Control Instruments
Empirical data on non-renewable natural resources
Optimal price development: the Hotelling-rule
Effects of exploration and Backstop-technology
Effects of different types of markets.
Biological growth function
Optimal depletion of renewable resources
Social inefficiency as result of over-use of open-access resources
Cost-benefit analysis and the environment
Measuring environmental benefit
Measuring costs
Concept of sustainability
Technological feasibility
Conflicts sustainability / optimality
Indicators of sustainability
Problem of climate change
Cost and benefit of climate change
Climate change as international ecological externality
International climate policy: Kyoto protocol
Implementation of the Kyoto protocol in Switzerland

Content
Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external externalities and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes
The script and lecture material are provided at:
https://moodle-app2.let.ethz.ch/course/view.php?id=140

Literature

376-1685-00L Training and Coaching I W 3 credits 2G O. Buholzer

Abstract
The combining of training and coaching as in the example of sport analysis, which has an effect on youth training and athlete development

Objective
- To develop basics for a differentiate analyses of sports (model)
- To develop a profile of requirements for specific sports
- To develop competencies of training with youth and talents
- To develop the basics of talent training in theory and practice
- To observe athletes in case studies, make judgments and conclusion
Das Modell der Sportartenanalyse
Die Relevanz der einzelnen Leistungsfaktoren
Das Modell der Wettkampfanalyse
Folgerungen für das Training und Coaching in der Sportart
Folgerungen für das Nachwuchstraining
Folgerungen für die Athletenauswahl, Athletenbeobachtung und -betreuung
Das Nachwuchs- und Talentraining (Sichtung, Selektion, Förderung)
Projekte aus der Praxis (Talent- und Nachwuchstraining)
Praxisinput zum Thema Koordination, motorische Grundbedürfnisse, Kraft und Gesundheit
Praxisbeispiele erarbeiten und planen
Konkrete Athletenbeobachtung

Lecture notes
Die Skript- (Lektionsunterlagen) werden im Rahmen des Semesters abgeben und auf Homepage veröffentlicht.

Literature
Struktur sportlicher Leistung (Modellsansatz von Gundlach; (Trainingswissenschaften S. 45 - 49; Stiehler/Konzag/Döbler)
Leistungsdiagnostische Verfahren, Stiehler (Konzag/Döbler)
Training fundiert erklärt, Handbuch der Trainingslehre, Ingold Verlag 2006
Das sportliche Talent, W. Joch, Meyer&Meyer Verlag, 2002
Das neue Konditionstraining, Grosser/Starischka/Zimmermann, blv 2002
Kredit/Prüfung
Für die Kreditvergabe sind die vorgeschriebenen Semesterarbeiten und die Präsenz zwingend. Die Benotung erfolgt durch eine schriftliche Arbeit.

Planung
Die Planungsunterlagen werden zu Semesterbeginn abgegebenen, sind provisorisch und können vom Dozenten geändert werden.
Die Praxislektionen werden jeweils am Mittwoch von 13.00 - 15.00 abgehalten. Die Termine werden in Absprache festgelegt.
Die Semesterarbeit ist 4 Wochen nach Semesterende abzugeben.


851-0588-00L Introduction to Game Theory. Models and Experimental Studies
Particularly suitable for students of D-MAVT, D-MATL

Abstract
This course introduces the foundations of game theory. It focuses on models of social interaction, conflict and cooperation, the emergence of cooperation and concepts of strategic decision-making behaviour. Examples, applications and the contrast between theory and empirical results are particularly emphasized.

Objective
Learn the fundamentals, models, and logic of thinking about game theory. Apply game theory models to strategic interaction situations and critically assess game theory's capabilities through a wide array of experimental results.

Content


In der Vorlesung wird Wert darauf gelegt, Modelle an Beispielen zu demonstrieren und empirische Untersuchungen ("experimentelle Spieltheorie") vorzustellen.

Lecture notes
On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems.


Weitere Literatur und Übungsaufgaben zum Download unter:
http://www.socio.ethz.ch/publications/spieltheorie

### 851-0585-43L Experimental Game Theory

**Objective**

Number of participants limited to 60

The course addresses principles and methods of experimental game theory. It focuses on experiments about social interaction, conflict and cooperation, emergence of cooperation and experimental validity of concepts for strategic behaviour in decision-making situations.

**Prerequisites / notice**

Um Missverständnisse zu vermeiden: Die Vorlesung ist für Hörerinnen und Hörer aller Departemente geeignet. (Nicht nur für D-MATL, D-MAVT)

**Literature**


(Von Handapparat dieser und weiterer Literatur wird in der D-GESS-Bibliothek bereitgestellt.)

Literatur zum Download befindet sich auch auf der Webseite:
http://www.socio.ethz.ch/publications/spieltheorie

**Lecture notes**

Foliendruck der Spieltheorie-Vorlesung und Literatur (Fachartikel, Kapitel aus Lehrbüchern) können auf der Webseite des Seminar eingesehen und heruntergeladen werden.

### 701-0985-00L Social Intercourse with Current Environmental Risks

**Objective**

The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.

**Prerequisites / notice**

Interesse am Thema und Motivation zur Mitarbeit. Der Besuch der Vorlesung "Spieltheorie" (851-0588-00 V, Dienstag, 15-17 Uhr) ist hilfreich.

**Literature**

Copies of slides and selected documents will be distributed

**Lecture notes**

The lecture is held biweekly (for 2 hours). The dates are 26.9., 3.10. (out of schedule), 24.10, 7.11, 21.11, 5.12, 19.12

### 701-0703-00L Environmental Ethics

**Objective**

The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

**Prerequisites / notice**

Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.

**Literature**

In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, 2nd Edition Zürich 2014
## Literature
- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O'Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008

## Prerequisites / notice
The procedure for accumulating CP will be explained at the start of term.
I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Laboratory</th>
<th>Instructor</th>
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</thead>
<tbody>
<tr>
<td>151-0757-00L</td>
<td>Environmental Management</td>
<td>W</td>
<td>2 credits</td>
<td>G</td>
<td>R. Züst</td>
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</tbody>
</table>

### Abstract
An environmental management system has the objective to continuously improve the environmental performance of the activities, products and services of a company. The company has to introduce different management procedures. The goal of this lecture is to provide basics and specific procedure to implement the environmental dimension in the planning and decision making processes of an organisation.

### Objective
Overview on environmental management and environmental management systems, general methods and principles.

### Content
- Introduction to environmental management / environmental management systems, energy and material flows; economical and ecological problems in industry; characterisation of an enterprise (incl. management handbook); structure and contents of an environmental management system; overview on the ISO 14001 ff. series; methods for environmental evaluation and assessment; integrated management systems; planning methodology and life-cycle-design design; planning examples

### Lecture notes
Information about environmental management and environmental management systems will be provided by a CD or mail.

### Literature
A list with literatures and links will be provided

### Prerequisites / notice
Delivery of a case study, worked out in groups. Language: Teaching in English on request.

### Public Policy Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>E-</th>
<th>Z</th>
<th>Dr</th>
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<tbody>
<tr>
<td>Q</td>
<td>Compulsory</td>
<td></td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<td>Courses outside the curriculum</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<td>Suitable for doctorate</td>
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### Key for Hours

<table>
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<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Statistics Master

The following courses belong to the curriculum of the Master's Programme in Statistics. The corresponding credits do not count as external credits even for course units where an enrolment at ETH Zurich is not possible.

Core Courses

In each subject area, the core courses offered are normally mathematical as well as application-oriented in content. For each subject area, only one of these is recognised for the Master degree.

Regression

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-0649-00L</td>
<td>Applied Statistical Regression</td>
<td>W</td>
<td>5</td>
<td>2V+1U</td>
<td>M. Dettling</td>
</tr>
</tbody>
</table>

Abstract

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student’s own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

Objective

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content

The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

Analysis of Variance and Design of Experiments

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<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0625-01L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W</td>
<td>5</td>
<td>2V+1U</td>
<td>L. Meier</td>
</tr>
</tbody>
</table>

Abstract


Objective

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content


Literature


Prerequisites / notice

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

Multivariate Statistics

No course offerings in this semester.

Time Series and Stochastic Processes

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-4623-00L</td>
<td>Time Series Analysis</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>N. Meinshausen</td>
</tr>
</tbody>
</table>

Abstract

Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Objective

Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

Content

This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

Mathematical Statistics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>401-3621-00L</td>
<td>Fundamentals of Mathematical Statistics</td>
<td>W</td>
<td>10</td>
<td>4V+1U</td>
<td>F. Balabdaoui</td>
</tr>
</tbody>
</table>

Abstract

The course covers the basics of inferential statistics.

Likelihood Inference (University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: STAA02
Specialization Areas and Electives

Statistical and Mathematical Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-3601-00L</td>
<td>Probability Theory</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>A.S. Sznitman</td>
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<tr>
<td></td>
<td>This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from none of the three course units 401-3601-00L Probability Theory, 401-3642-00L Brownian Motion and Stochastic Calculus resp. 401-3692-00L Applied Stochastic Processes for their Bachelor's degree still can have recognised this course for the Master's degree. Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.</td>
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<tr>
<td></td>
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<td></td>
<td>Basics of probability theory and the theory of stochastic processes in discrete time</td>
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<td>Objective</td>
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<td></td>
<td>This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned: Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.</td>
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<td>Content</td>
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<td>Lecture notes</td>
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<td>available, will be sold in the course</td>
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<td>Literature</td>
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<td></td>
<td>H. Bauer, Probability Theory, de Gruyter 1996</td>
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<td></td>
<td>J. Jacod and P. Protter, Probability essentials, Springer 2004</td>
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<td></td>
<td>A. Klenke, Wahrscheinlichkeitstheorie, Springer 2006</td>
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<td></td>
<td>D. Williams, Probability with martingales, Cambridge University Press 1991</td>
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<tr>
<td>401-3627-00L</td>
<td>High-Dimensional Statistics</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>P. L. Bühlmann</td>
</tr>
<tr>
<td></td>
<td>“High-Dimensional Statistics” deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Knowledge of methods and basic theory for high-dimensional statistical inference</td>
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<td>Objective</td>
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<td>This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned: Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.</td>
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<tr>
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<td>Content</td>
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<td></td>
<td>Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling</td>
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<td></td>
<td>Lecture notes</td>
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<td>available, will be sold in the course</td>
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<tr>
<td></td>
<td>Literature</td>
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<tr>
<td>401-3612-00L</td>
<td>Stochastic Simulation</td>
<td>W</td>
<td>5 credits</td>
<td>3G</td>
<td>F. Sigrist</td>
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<tr>
<td></td>
<td>This course provides an introduction to statistical Monte Carlo methods. This includes applications of simulations in various fields (Bayesian statistics, statistical mechanics, operations research, financial mathematics), algorithms for the generation of random variables (accept-reject, importance sampling), estimating the precision, variance reduction, introduction to Markov chain Monte Carlo.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>Stochastic simulation (also called Monte Carlo method) is the experimental analysis of a stochastic model by implementing it on a computer. Probabilities and expected values can be approximated by averaging simulated values, and the central limit theorem gives an estimate of the error of this approximation. The course shows examples of the many applications of stochastic simulation and explains different algorithms used for simulation. These algorithms are illustrated with the statistical software R.</td>
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<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>Content</td>
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<td>A script will be available in English.</td>
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<td></td>
<td>Literature</td>
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<tr>
<td>401-3611-00L</td>
<td>Advanced Topics in Computational Statistics</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>M. H. Maathuis</td>
</tr>
<tr>
<td></td>
<td>This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.</td>
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<td>Notice</td>
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<td></td>
<td>Familiarity with basic concepts of probability theory (random variables, joint and conditional distributions, laws of large numbers and central limit theorem) will be assumed.</td>
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</tbody>
</table>

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1400 of 1571
The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

Lecture notes
Lecture notes.

Prerequisites / notice
We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

<table>
<thead>
<tr>
<th>401-4633-00L</th>
<th>Data Analytics in Organisations and Business</th>
<th>W</th>
<th>5 credits</th>
<th>2V+1U</th>
<th>I. Flückiger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>On the end-to-end process of data analytics in organisations &amp; business and how to transform data into insights for fact based decisions. Presentation of the process from the beginning with framing the business problem to presenting the results and making decisions by the use of data analytics. For each topic case studies from the financial service, healthcare and retail sectors will be presented.</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to give the students the understanding of the data analytics process in the business world, with special focus on the skills and techniques used besides the technical skills. The student will become familiar with the &quot;business language&quot;, current problems and thinking in organisations and business and tools used.</td>
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<tr>
<td>Content</td>
<td>Framing the Business Problem Framing the Analytics Problem Data Methodology Model Building Deployment Model Lifecycle Soft Skills for the Statistical/Mathematical Professional</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture Notes will be available.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Basic statistics and probability theory and regression</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>401-6217-00L</th>
<th>Using R for Data Analysis and Graphics (Part II)</th>
<th>W</th>
<th>1 credit</th>
<th>1G</th>
<th>A. Drewek, A. J. Papritz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The course provides the second part an introduction to the statistical software R for scientists. Topics are data generation and selection, graphical functions, important statistical functions, types of objects, models, programming and writing functions. Note: This part builds on &quot;Using R ... (Part I)&quot;, but can be taken independently if the basics of R are already known.</td>
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<tr>
<td>Objective</td>
<td>The students will be able to use the software R efficiently for data analysis.</td>
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<tr>
<td>Content</td>
<td>The course provides the second part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.</td>
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<tr>
<td>Lecture notes</td>
<td>An Introduction to R. <a href="http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf">http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf</a></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Basic knowledge of R equivalent to &quot;Using R ... (part 1)&quot; (= 401-6215-00L) is a prerequisite for this course.</td>
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</tbody>
</table>

The course resources will be provided via the Moodle web learning platform Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145

Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

<table>
<thead>
<tr>
<th>401-0627-00L</th>
<th>Smoothing and Nonparametric Regression with R</th>
<th>W</th>
<th>4 credits</th>
<th>2G</th>
<th>S. Beran-Ghosh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Starting with an overview of selected results from parametric inference, kernel smoothing (including local polynomials) will be introduced along with some asymptotic theory, optimal bandwidth selection, data driven algorithms and some special topics. Examples from environmental research will be used for motivation, but the methods will also be applicable elsewhere.</td>
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<tr>
<td>Objective</td>
<td>The students will learn about methods of kernel smoothing and application of concepts to data. The aim will be to build sufficient interest in the topic and intuition as well as the ability to implement the methods to various different datasets.</td>
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<tr>
<td>Content</td>
<td>Rough Outline:</td>
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<tr>
<td></td>
<td>- Parametric estimation methods: selection of important results</td>
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<td></td>
<td>o Maximum likelihood</td>
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<tr>
<td></td>
<td>o Least squares: regression &amp; diagnostics</td>
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<td></td>
<td>- Nonparametric curve estimation</td>
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<tr>
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<td>o Density estimation, Kernel regression, Local polynomials, Bandwidth selection</td>
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<td>o Selection of special topics (as time permits, we will cover as many topics as possible) such as rapid change points, mode estimation, robust smoothing, partial linear models, etc.</td>
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<tr>
<td>Lecture notes</td>
<td>Brief summaries or outlines of some of the lecture material will be posted at <a href="http://www.wsl.ch/info/mitarbeitende/ghosh/index_EN">http://www.wsl.ch/info/mitarbeitende/ghosh/index_EN</a> (click on &quot;ETH Course&quot; in the left panel).</td>
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NOTE: The posted notes will tend to be just sketches whereas only the in-class lessons will contain complete information.

LOG IN: In order to have access to the posted notes, you will need the course user id & the password. These will be given out on the first day of the lectures.
Additional references will be given out in the lectures.

Nonparametric and Resampling Methods (M. Mächler)

For classical parametric models there exist optimal statistical estimators and test statistics whose distributions can often be determined exactly. The methods covered in this course allow for finding statistical procedures for more general models and to derive exact or approximate distributions of complicated estimators and test statistics.

Prerequisites: A background in Linear Algebra, Calculus, Probability & Statistical Inference including Estimation and Testing.

Nonparametric and Resampling Methods (M. Mächler)

Nonparametric tests, randomization tests, jackknife and bootstrap, as well as asymptotic properties of estimators.

Knowledge on estimation of probability densities and regression functions via various statistical methods.

After an introductory discussion of the types of problems and the kind of data that arise in environmental research, an introduction into spatial statistics is given. The course will provide an overview of the basic concepts and stochastic models that are commonly used to model spatial data. In addition, the special case of spatial processes needs to be considered.

The course will provide an overview of the basic concepts and stochastic models that are commonly used to model spatial data. In addition, the participants will learn a number of geostatistical techniques and acquire some familiarity with software that is useful for analysing spatial data.

The focus of this course is on one dimension, higher dimensions and samples of curves are treated briefly. Exercises at the computer.

In many research fields, spatially referenced data are collected. When analysing such data the focus is either on exploring their structure (dependence of explanatory variables, autocorrelation) and/or on spatial prediction. The course provides an introduction to geostatistical methods that are useful for such purposes.

The participants will learn a number of geostatistical techniques and acquire some familiarity with software that is useful for analysing spatial data.

Topics covered:
- Dealing with large data (Data centers; Map-Reduce/Hadoop; Amazon Mechanical Turk)
- Fast nearest neighbor methods (Shingling, locality sensitive hashing)
- Online learning (Online optimization and regret minimization, online convex programming, applications to large-scale Support Vector Machines)
- Multi-armed bandits (exploration-exploitation tradeoffs, applications to online advertising and relevance feedback)
- Active learning (uncertainty sampling, pool-based methods, label complexity)
- Dimension reduction (random projections, nonlinear methods)
- Data streams (Sketches, coresets, applications to online clustering)
- Recommender systems

Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.
Topics to be covered include Sampling Surveys  
E. W. Farkas
Knowledge of the Elements and the process of a sample survey. Understanding of the paradigm of random samples. Knowledge of simple sampling and estimation as well as data preparation and analysis.

Part 1, Classification: logistic regression, linear/quadratic discriminant analysis, Bayes classifier; additive and tree models; further flexible ("nonparametric") methods.

Part 2, Flexible Prediction: additive models, MARS, Y-Transformation models (ACE,AVAS); Projection Pursuit Regression (PPR), neural nets.

"Data Mining" is a large field from which in this block course, we only treat so called prediction problems, aka "supervised learning".

Part 1, Classification, recalls logistic regression and linear / quadratic discriminant analysis (LDA/QDA) and extends these (in the framework of "Bayes classifier") to (generalized) additive (GAM) and tree models (CART), and further mentions other flexible ("nonparametric") methods.

Part 2, Flexible Prediction of (continuous or "class" response/target) contains additive models, MARS, Y-Transformation models (ACE, AVAS); Projection Pursuit Regression (PPR), neural nets.

Data Mining is a large field from which in this block course, we only treat so called prediction problems, aka "supervised learning".

This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

The exercises are done exclusively with the (free, open source) software “R” (http://www.r-project.org). A final exam will also happen at the computers, using R (and your brains!).

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>W</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
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<tbody>
<tr>
<td>401-6289-00L</td>
<td>Sampling Surveys</td>
<td>W</td>
<td>2</td>
<td>1G</td>
</tr>
<tr>
<td>401-6273-00L</td>
<td>Bayes Methods</td>
<td>W</td>
<td>2</td>
<td>2G</td>
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<tr>
<td>401-3913-01L</td>
<td>Mathematical Foundations for Finance</td>
<td>W</td>
<td>4</td>
<td>3V+2U</td>
</tr>
<tr>
<td>401-3901-00L</td>
<td>Mathematical Optimization</td>
<td>W</td>
<td>11</td>
<td>4V+2U</td>
</tr>
</tbody>
</table>
Mathematical treatment of diverse optimization techniques.

Advanced optimization theory and algorithms.

1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas’ Lemma and infeasibility certificates, duality theory of linear programming.


3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.

4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

**401-6282-00L**  
**Statistical Analysis of High-Throughput Genomic and Transcriptional Data (University of Zurich)**  
*No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.*  
**UZH Module Code: STA435**

Mind the enrolment deadlines at UZH:  

**Objective**  
- Understand the fundamental "scientific process" in the field of Statistical Bioinformatics
- Be equipped with the skills/tools to preprocess genomic data (Unix, Bioconductor, mapping, etc.) and ensure reproducible research (Sweave)
- Have a general knowledge of the types of data and biological applications encountered with microarray and sequencing data
- Have the general knowledge of the range of statistical methods that get used with microarray and sequencing data
- Gain the ability to apply statistical methods/knowledge/software to a collaborative biological project
- Gain the ability to critically assess the statistical bioinformatics literature
- Write a coherent summary of a bioinformatics problem and its solution in statistical terms
- Lectures will include: microarray preprocessing; normalization; exploratory data analysis techniques such as clustering, PCA and multidimensional scaling; Controlling error rates of statistical tests (FPR versus FDR versus FWER); limma (linear models for microarray analysis); mapping algorithms (for RNA/ChIP-seq); RNA-seq quantification; statistical analyses for differential count data; isoform switching; epigenomics data including DNA methylation; gene set analyses; classification

**Content**

**Lecture notes**

[License notes](http://www.uzh.ch/studies/application/mobilitaet_en.html)

**Prerequisites / notice**

Prerequisites: Basic knowledge of the programming language R, sufficient knowledge in statistics

Former course title: Statistical Methods for the Analysis of Microarray and Short-Read Sequencing Data

**401-8625-00L**  
**Statistical Methods in Clinical Research (University of Zurich)**  
*No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.*  
**UZH Module Code: STA404**

Mind the enrolment deadlines at UZH:  

**Objective**

Discussion of the different statistical methods that are used in clinical research.

**Content**

Discussion of the different statistical methods that are used in clinical research. Among other subjects the following will be introduced: sample size calculation, randomization and blinding, analysis of clinical trials (parallel groups design, analysis of covariance, crossover design, equivalence studies), intention-to-treat analysis, multiple testing, group sequential methods, adaptive designs, diagnostic studies, and agreement studies.

**Literature**


**Prerequisites / notice**

Basic knowledge of the programming language R, sufficient knowledge in calculus, linear algebra, probability, statistics

**252-0535-00L**  
**Machine Learning**  
*8 credits 3V+2U+2A*  
**J. M. Buhmann**

**Abstract**

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

**Objective**

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.
Using R for Data Analysis and Graphics (Part I)

The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Note: Part I of UsingR is complemented and extended by Part II, which is offered during the second part of the semester and which can be taken independently from Part I.

Prerequisites / notice
The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

Statistical and Mathematical Courses: not eligible for credits

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-6215-00L</td>
<td>Using R for Data Analysis and Graphics (Part I)</td>
<td>E-</td>
<td>1</td>
<td>1G</td>
<td>A. Drewek, A. J. Papritz</td>
</tr>
</tbody>
</table>

Abstract
The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

Objective
The students will be able to use the software R for simple data analysis.

Content
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Application Areas
Students select one area of application and look for suitable courses in which quantitative methods and modeling play a role. They need the consent by the Advisor (http://stat.ethz.ch/~kalisch/) that the chosen courses are eligible in the category "Application Areas".

For the category assignment of eligible courses keep the choice "no category" and take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat/staff/ekuenti) after having received the credits. The Study Administration Office needs the Advisor's consent.

Seminar or Semester Paper

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tr>
<td>401-3630-06L</td>
<td>Semester Paper</td>
<td>No direct enrolment to this course unit in myStudies. Please fill in the online application form. Requirements and application form under <a href="http://www.math.ethz.ch/intranet/students/study-administration/theses.html">www.math.ethz.ch/intranet/students/study-administration/theses.html</a></td>
<td>W</td>
<td>6</td>
<td>9A</td>
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</tbody>
</table>

Abstract
Semester papers serve to delve into a problem in statistics and to study it with the appropriate methods or to compile and clearly exhibit a case study of a statistical evaluation.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3630-04L</td>
<td>Semester Paper</td>
<td>No direct enrolment to this course unit in myStudies. Please fill in the online application form. Requirements and application form under <a href="http://www.math.ethz.ch/intranet/students/study-administration/theses.html">www.math.ethz.ch/intranet/students/study-administration/theses.html</a></td>
<td>W</td>
<td>4</td>
<td>6A</td>
</tr>
</tbody>
</table>
Abstract
Semester papers serve to delve into a problem in statistics and to study it with the appropriate methods or to compile and clearly exhibit a case study of a statistical evaluation.

252-5051-00L Advanced Topics in Machine Learning ★ W 2 credits 2S J. M. Buhmann, T. Hofmann, A. Krause, G. Rätsch

Abstract
In this seminar, recent papers of the pattern recognition and machine learning literature are presented and discussed. Possible topics cover statistical models in computer vision, graphical models and machine learning.

Objective
The seminar "Advanced Topics in Machine Learning" familiarizes students with recent developments in pattern recognition and machine learning. Original articles have to be presented and critically reviewed. The students will learn how to structure a scientific presentation in English which covers the key ideas of a scientific paper. An important goal of the seminar presentation is to summarize the essential ideas of the paper in sufficient depth while omitting details which are not essential for the understanding of the work. The presentation style will play an important role and should reach the level of professional scientific presentations.

Content
The seminar will cover a number of recent papers which have emerged as important contributions to the pattern recognition and machine learning literature. The topics will vary from year to year but they are centered on methodological issues in machine learning like new learning algorithms, ensemble methods or new statistical models for machine learning applications. Frequently, papers are selected from computer vision or bioinformatics - two fields, which relies more and more on machine learning methodology and statistical models.

Literature
The papers will be presented in the first session of the seminar.

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-MATH.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Master's Thesis

Number Title Type ECTS Hours Lecturers
401-2000-00L Scientific Works in Mathematics O 0 credits E. Kowalski

Abstract
Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)

Objective
Learn the basic standards of scientific works in mathematics.

Content
- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519

Prerequisites / notice
This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

401-4990-02L Master's Thesis ★ O 30 credits 57D Professors

Abstract
The master's thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

Objective
Thesis work should prove the students' ability to independent, structured and scientific working.

Content
Five-month project to solve a research question. The content can be more theoretical (e.g. proving a new result) or applied (developing new methods or making a very sophisticated application and adapting existing methods).

Prerequisites / notice
Supervisors are chosen on a first-come-first-served basis. Collaborations with industry are possible.

Statistics Master - Key for Type

Dr Suitable for doctorate
W+ Eligible for credits and recommended
W Eligible for credits

E- Recommended, not eligible for credits
Z Courses outside the curriculum
O Compulsory

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1406 of 1571
| Key for Hours | | |
|---------------|---------------|
| V             | lecture       |
| G             | lecture with exercise |
| U             | exercise      |
| S             | seminar       |
| K             | colloquium    |
| P             | practical/laboratory course |
| A             | independent project |
| D             | diploma thesis |
| R             | revision course / private study |

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### First Year Examinations (1. Sem.)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0241-00L</td>
<td>Analysis I</td>
<td>O</td>
<td>7 credits</td>
<td>5V+2U</td>
<td>M.h. Akka Ginosar</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Mathematical tools for the engineer</td>
<td></td>
<td></td>
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<tr>
<td><strong>Objective</strong></td>
<td>Mathematics as a tool to solve engineering problems.</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Complex numbers. Calculus for functions of one variable with applications. Simple Mathematical models in engineering.</td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Die Vorlesung folgt weitgehend</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Literature</strong></td>
<td>Klaus Dürrschnabel, &quot;Mathematik für Ingenieure - Eine Einführung mit Anwendungs- und Alltagsbeispielen&quot;, Springer; online verfügbar unter: <a href="http://link.springer.com/book/10.1007/978-3-8348-2559-9/page/1">link</a></td>
<td></td>
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<tr>
<td></td>
<td>Neben Klaus Dürrschnabel, &quot;Mathematik für Ingenieure - Eine Einführung mit Anwendungs- und Alltagsbeispielen&quot;, Springer sind auch die folgenden Bücher/Skripte empfehlenswert und decken den zu behandelnden Stoff ab:</td>
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<td></td>
<td>Tilo Arens et al., &quot;Mathematik&quot;, Springer; online verfügbar unter: <a href="http://link.springer.com/book/10.1007/978-3-642-44919-2/page/1">link</a></td>
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<tr>
<td></td>
<td>Urs Stammbach, &quot;Analysis III&quot; (erhältlich im ETH Store); <a href="https://people.math.ethz.ch/~stammb/analysisskript.html">link</a></td>
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</tr>
<tr>
<td>401-0141-00L</td>
<td>Linear Algebra and Numerical Analysis</td>
<td>O</td>
<td>5 credits</td>
<td>3V+1U</td>
<td>V. C. Gradinaru, R. Käppeli</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction to Linear Algebra and Numerical Analysis with emphasis on both abstract concepts and algorithms.</td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>To acquire basic knowledge of Linear Algebra and Numerical Methods. Enhanced capability for abstract and algorithmic thinking based on mathematical concepts and models. Ability to select appropriate numerical linear algebra methods, to apply them properly and to implement them efficiently in MATLAB.</td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Für weitere Informationen: <a href="http://www.sam.math.ethz.ch/~grsam/HS16/LABAUG/index.html">link</a></td>
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</tr>
<tr>
<td><strong>Literature</strong></td>
<td>K. Nipp, D. Stoffer, Lineare Algebra, VdF Hochschulverlag ETH</td>
<td></td>
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<tr>
<td></td>
<td>G. Strang, Lineare Algebra, Springer</td>
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</tr>
<tr>
<td>252-0845-00L</td>
<td>Computer Science I</td>
<td>O</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>M. Hirt</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The course covers the basic concepts of computer programming.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Basic understanding of programming concepts. Students will be able to write and read simple programs and to modify existing programs.</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Variablen, Typen, Kontrollanweisungen, Prozeduren und Funktionen, Scoping, Rekursion, dynamische Programmierung, vektorisierte Programmierung, Effizienz. Als Lernsprachen werden Pascal und Matlab verwendet.</td>
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</tr>
<tr>
<td>101-0031-01L</td>
<td>Systems Engineering</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>B. T. Adey, C. Richmond</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>An introduction to system development, analysis and optimization, and decision making, with focus on linear programming, networks, formal decision methods and economic analysis.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>- to gain competency in methods used to plan and analyse systems - to gain the ability to formulate, analyse and solve complex problems - to gain competency in the methods used for the evaluation of multiple solutions</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>- Introduction - System development - System analysis - Networks - Decision theory - Economic analysis - Cost-benefit analysis</td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Script and transparencies as well as additional material via Moodle. The transparencies will be provided via Moodle two days before the respective class.</td>
<td></td>
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</tr>
<tr>
<td>651-0032-00L</td>
<td>Geology and Petrography</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>C. A. Heinrich, S. Löw, K. Rauchenstein</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts. The course consists of lectures and exercises in groups. The lectures cover all aspects of the dynamic earth, from the history of the earth, to the formation of rocks, mountains, and oceans, and the degradation processes shaping the uppermost earth's crust.</td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts.</td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Übungen zum Gesteinsbestimmen und Lesen von geologischen, tektonischen und geotechnischen Karten, einfache Konstruktionen.</td>
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</tr>
<tr>
<td><strong>Literature</strong></td>
<td>The course is based on the book Dynamic Earth from Press &amp; Siever</td>
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</tbody>
</table>
3. Semester

Compulsory Courses 3. Semester

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0023-01L</td>
<td>Physics</td>
<td>O</td>
<td>7 credits</td>
<td>5+2U</td>
<td>L. Degiorgi</td>
</tr>
<tr>
<td>101-0203-01L</td>
<td>Hydraulics I</td>
<td>O</td>
<td>5 credits</td>
<td>3V+1U</td>
<td>R. Stocker</td>
</tr>
<tr>
<td>103-0233-01L</td>
<td>GIS I</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Raulan</td>
</tr>
<tr>
<td>102-0293-00L</td>
<td>Hydrology</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Burlando</td>
</tr>
</tbody>
</table>

Abstract

Physics: This course will cover the basic topics in Physics and will show/display/explain with a variety of experiments the most important physical effects. The course will address classical as well as modern physics, and the interplay between basic research and applications.

Hydraulics I: The course teaches the basics of hydromechanics, relevant for civil and environmental engineers. Familiarization with the basics of hydromechanics of steady state flows.

GIS I: Fundamentals of geoinformation technologies: spatial data modeling, metrics & topology, vector and raster data, thematic data, spatial queries and analysis, spatial databases; labs with GIS software.

Hydrology: The course introduces the students to engineering hydrology. It covers first physical hydrology, that is the description and the measurement of hydrological processes (precipitation, interception, evapotranspiration, runoff, erosion, snow), and it introduces then the basic mathematical models of the single processes and of the rainfall-runoff transformation, thereby including flood analysis.

Objective

Physics: The course will cover the basics of Physics and will show/display/explain with a variety of experiments the most important physical effects. The course will address classical as well as modern physics, and the interplay between basic research and applications.

Hydraulics I: The course teaches the basics of hydromechanics, relevant for civil and environmental engineers.

GIS I: The course teaches the basics of geoinformation technologies: spatial data modeling, metrics & topology, vector and raster data, thematic data, spatial queries and analysis, spatial databases; labs with GIS software.

Hydrology: The course introduces the students to engineering hydrology. It covers first physical hydrology, that is the description and the measurement of hydrological processes (precipitation, interception, evapotranspiration, runoff, erosion, snow), and it introduces then the basic mathematical models of the single processes and of the rainfall-runoff transformation, thereby including flood analysis.

Literature

Physics: Hans J. Paus, Physik in Experimenten und Beispielen, Carl Hanser Verlag München Wien (als unterrichtsbegleitendes und ergänzendes Lehrbuch)


Biology III: Essentials of Ecology

Objective
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the individual, the population, the community and the ecosystem level.

Content
- The objectives of the lectures are demonstrated. In a more applied part of the lecture threats to biodiversity and the appropriate management are discussed.

Lecture notes
Die Kopie der Folien zur Vorlesung können auf den Webseiten der Professur für Hydrologie und Wasserwirtschaft heruntergeladen werden. Die Kopie der Folien zur Vorlesung können auf den Webseiten der Professur für Hydrologie und Wasserwirtschaft heruntergeladen werden.

Literature

Prerequisites / notice
Vorlesungen zu verstehen notwendig ist, kann zusammengefasst werden, wie hintereinander es bescrieben wird: Elementare Datenverarbeitung: Hydrologische Messungen und Daten, Datenreduzierung (grafische Darstellungen und numerische Kenngrößen).

701-0243-01L

Microbiology

Abstract
Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.

Objective
Teaching of basic knowledge in microbiology.

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1410 of 1571

Wird von den jeweiligen Dozenten ausgegeben.

Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, *Biology of Microorganisms*.

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### Biochemistry (Biochemistry 2018-2019)

**Course Information**

**Number**: 701-0255-00L

**Lecturer**: H.P. Kohler

**Credit Value**: 2 credits

**Type**: 2V

**Hours**: 4S

---

#### Abstract

Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes.

#### Objective

- Students are able to understand
  - the structure and function of biological macromolecules
  - the kinetic bases of enzyme reactions
  - thermodynamic and mechanistic basics of relevant metabolic processes
  - Students are able to describe the relevant metabolic reactions in detail

#### Content

**Program**

- Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
- Structure and function of proteins
- Carbohydrates
- Lipids and biological membranes
- Enzymes and enzyme kinetics
- Catalytic strategies
- Metabolism: Basic concepts and design. Repetition of basic thermodynamics
- Glycolysis, fermentation
- The citric acid cycle
- Oxidative phosphorylation
- Fatty acid metabolism

**Lecture notes**

Horton et al. (Pearson) serves as lecture notes.

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### Autumn Semester 2016

#### Compulsory Courses 5. Semester

##### Examination Block 3

As of examination session winter 2015, examination block 3 will be implemented in its new structure (i.e. new, Earth Observation will be examined within examination block 3 instead of within examination block 4). The new structure is valid for those students NOT having taken exams of examination block 3 nor of examination block 4 for the first time. All other students take the exams of examination block 3 as well as of examination block 4 in the present structure, including repetition where applicable.

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0215-00L</td>
<td>Urban Water Management II</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Maurer, P. Staufer</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Consolidation of the basic procedures for design and operation of technical networks in water engineering.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>Written material and copies of the overheads will be available. Prerequisite: Introduction to Urban Water Management</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>Basic knowledge in biology and chemistry is a precondition.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0455-01L</td>
<td>Groundwater I</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Willmann</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>The course provides an introduction into quantitavie analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.</td>
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<tr>
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<td>b) Students are able to formulate simple practical flow and transport problems.</td>
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<tr>
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<td>c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.</td>
</tr>
</tbody>
</table>
Content

Introduction, aquifers, groundwater use, sustainability, porosity.
Properties of porous media.
Exercises: Groundwater use, porosity, grain size analysis.
Flow properties, Darcy’s law, filter.
Flow equations, stream function.
Exercises: Darcy’s law.
Analytical solutions, confined aquifers, steady-state flow.
Exercises: Head isolines.
Use of superposition principles, transient flow, free surface flow.
Exercises: Analytical solutions to flow problems.
Finite difference solutions to flow problems I.
Exercises: Analytical solutions to flow problems.
Finite difference solutions to flow problems II.
Exercises: Finite difference formulations to flow problems.
Flow properties, Darcy’s law, filter.
Exercises: Computer workshop using PMWIN.
Analytical solutions to transport problems I.
Exercises: Computer workshop using PMWIN.
Analytical solutions to transport problems II.
Exercises: Analytical solutions to transport problems.
Path lines, groundwater protection.
Exercises: Analytical solutions to transport problems.
Groundwater remediation, groundwater management.
Exercises: Groundwater remediation.
Lecture notes
Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index
Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index
Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index
Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

Literature
W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995
Kruisemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970
G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

102-0635-01L Air Pollution Control O 6 credits 4G B. Buchmann, P. Hofer

Abstract
The lecture provides in the first part an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and their impact on air quality. The second part covers different strategies and techniques for emission reduction. The basic knowledge is deepened by the discussion of specific air pollution problems of today’s society.

Objective
The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost. The students know the different techniques of air pollution control and their scientific basements. They are able to incorporate goals concerning the air quality into their engineering work.

Content
Part 1 Emission, Immission, Transmission
Fluxes of pollutants and their environmental impact
- physical and chemical processes leading to emission of pollutants
- mass and energy of processes
- Emission measurement techniques and concepts
- quantification of emissions from individual and aggregated sources
- extent and development of the emissions (Switzerland and global)
- propagation and transport of pollutants (transmission)
- meteorological parameters influencing air pollution dispersion
- deterministic and stochastic models, describing the air pollution dispersion
- dispersion models (Gaussian model, box model, receptor model)
- measurement concepts for ambient air (immission level)
- extent and development of ambient air mixing ratios
- goal and instrument of air pollution control

Part 2 Air Pollution Control Technologies
- The reduction of the formation of pollutants is done by modifying the processes (process-integrated measures) and by different engineering operations for the cleaning of waste gas (downstream pollution control). It will be demonstrated, that the variety of these procedures can be traced back on the application of a few basic principles of physical chemistry.
- Procedures for the removal of particles (inertial separator, filtration, electrostatic pre-cipitators, scrubbers) with their different mechanisms (field forces, impaction and diffusion processes) and the modelling of these mechanisms.
- Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biological conversions).
- Discussion of the technical possibilities to solve the actual air pollution problems.
The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for bio/geophysical environmental parameter estimation. Students should know at the end of the course:

1. Basics of measurement principle
2. Fundamentals of image acquisition
3. Basics of the sensor-specific geometries
4. Sensor-specific determination of environmental parameters

The course aims to give an insight into the current Earth observation with the following topics:

1. Introduction to remote sensing from air and space
2. Introduction to the electromagnetic spectrum
3. Introduction to optical systems (optical and hyperspectral)
4. Introduction to microwave technology (active and passive)
5. Introduction to atmospheric systems (meteorological and chemical)
6. Introduction to the techniques and methods for the determination of environmental parameters
7. Introduction to the applications for the determination of environmental parameters in hydrology, glaciology, forestry and land use, geology and topography

Lecture notes: Folien zu jedem Vorlesungsblock werden zur Verfügung gestellt.

Literature: Ausgewählte Literatur wird am Anfang der Vorlesung vorgestellt.

Exam Block 4

In place of the German course 851-0703-03L Introduction to Law for Civil Engineering students can take the French course 851-0709-00L Droit civil. As of examination session summer 2015, examination block 4 will be implemented in its new structure (i.e. new. Earth Observation will be examined within examination block 3 instead of within examination block 4). The new structure is valid for those students NOT having taken exams of examination block 3 nor of examination block 4 for the first time. All other students take the exams of examination block 3 as well as of examination block 4 in the present structure, including repetition where applicable.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
101-0031-02L | Business Administration | O | 2 credits | 2V | M. Passardi

Abstract
Introduction to business administration
Principles of accounting and financial management
Financial planning and capital budgeting of projects
Costing systems by corporations

Objective
Prepare and analyze the financial statements of organizations
Establish budget and determine profitability of investment
Understand the major costing systems
Perform some product calculations

Content
Overview in business administration
Financial Accounting
- Balance sheet, income statement
- Accounts, double-entry bookkeeping
- Year-end closing and financial statements
Financial Management
- Financial statement analysis
- Financial planning
- Investment decisions
Management Accounting
- Full costing and marginal costing
- Product costing
- Management decisions

851-0703-03L | Introduction to Law for Civil Engineering | W | 2 credits | 2V | G. Hertig

Abstract
This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.

Objective
Introduction to fundamental questions of public and private law which serves as a foundation for more advanced law classes.

Content
1. Public Law
Constitutional law: sources of law, organization of the state, fundamental rights. Administrative law: administrative decisions, organization of the administration, enforcement of administrative decisions, procedural law, basics of police, environmental and zoning law.
2. Private law

Lecture notes
There are 'Lecture Notes' (in German) for this course.

Literature
Further information is available at http://www.hertig.ethz.ch/education/grundzuege-des-rechts-fuer-baug-und-arch.html
### Introduction to Civil Law

**Abstract**
The course Private Law focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In addition, the course will provide a short overview of Civil Procedure and Enforcement.

**Objective**

**Content**
Le cours de droit civil porte notamment sur le droit des obligations (droit des contrats et responsabilité civile) et sur les droits réels (propriété, gages et servitudes). De plus, il est donné un bref aperçu du droit de la procédure et de l'exécution forcée.

**Literature**
Editions officielles récentes des lois fédérales, en langue française (Code civil et Code des obligations) ou italienne (Codice civile e Codice delle obbligazioni), disponibles auprès de la plupart des bibliothèques.

Sont indispensables:
- Le code civil et le Code des obligations;
- Sont conseillés:
  - Nef, Urs Ch.: Le droit des obligations à l'usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
  - Boilod, J.-P.; Manuel de droit, éd Staktine, Genève

**Prerequisites / notice**
Remarques
- Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours "Recht I" et "Recht II" en langue allemande et des exercices y relatifs.
- Les examens peuvent se faire en français ou en italien.
- Examen au 1er propédeutique; convient pour travail de semestre.

**ECTS**
3 credits

**Type**
2V

**Lecturers**
H. Peter

---

### Environmental Engineering Seminars

**Abstract**
The course is organized in the form of seminars held by the students. Topics selected from the core disciplines of the curriculum (water resources, urban water engineering, material fluxes, waste technology, air pollution, earth observation) are discussed in the class on the basis of scientific papers that are illustrated and critically reviewed by the students.

**Objective**
Learn about recent research results in environmental engineering and analyse practical applications in environmental engineering.

**Prerequisites / notice**
Copies of all necessary documents will be distributed at appropriate times.

**ECTS**
3 credits

**Type**
3S

**Lecturers**

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### Additional Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0515-01L</td>
<td>Environmental Engineering Seminars</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>M. Kersting</td>
</tr>
</tbody>
</table>

**Abstract**
The course is organized in the form of seminars held by the students. Topics selected from the core disciplines of the curriculum (water resources, urban water engineering, material fluxes, waste technology, air pollution, earth observation) are discussed in the class on the basis of scientific papers that are illustrated and critically reviewed by the students.

**Objective**
Learn about recent research results in environmental engineering and analyse practical applications in environmental engineering.

---

### Elective Blocks

#### Elective Block: Environmental Planning

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0535-00L</td>
<td>Noise Abatement</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>K. Eggenschwiler, J. M. Wunderli</td>
</tr>
</tbody>
</table>

**Abstract**

**Objective**
The students will understand the basics of noise abatement: acoustics, impact of noise, measurement techniques and legislation. The students will be able to analyze different noise problem-sets and they will be able to solve simple problems of noise abatement.

**Content**

**Lecture notes**
Skript "Lärmbekämpfung" erhalten zu Beginn der Vorlesung.

**Prerequisites / notice**
Corinne.Gianola@empa.ch

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### Elective Block: Soil Protection

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0501-00L</td>
<td>Pedosphere</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Kretzschmar</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.
Hydraulic fundamentals are applied to hydraulic structures for wastewater, flood protection and hydropower. Typical case studies from environmental geotechnics can be purchased during the first lecture (15.- SFr).

**Lecturers**


**Prerequisites / notice**

- Prerequisites: Basic knowledge in chemistry, biology and geology.

### Elective Block: Civil Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0339-00L</td>
<td>Environmental Geotechnics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. M. Plötzke</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk management, remediation and reclamation techniques as well as monitoring systems. Introduction in landfill design and engineering with focus on barrier- and drainage systems and lining materials, evaluation of geotechnical problems, e.g. stability.</td>
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<tr>
<td>Objective</td>
<td>Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk management, remediation and reclamation techniques as well as monitoring systems. Introduction in landfill design and engineering with focus on barrier- and drainage systems as well as lining materials, evaluation of geotechnical problems, e.g. stability.</td>
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</tr>
<tr>
<td>Content</td>
<td>Definition of contaminated sites, site investigation methods, historical research and technical investigation, risk assessment, contamination transport, remediation, clean-up and retaining techniques (e.g. bioremediation, incineration, retaining walls, pump-and-treat, permeable reactive barriers), monitoring, research projects and results.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts in lectures.</td>
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</table>

**Prerequisites / notice**

- Dr. R. Hermanns Stengele, Dr. M. Plötzle: Environmental Geotechnics (german) digital excursion

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<tr>
<td>101-1249-00L</td>
<td>Hydraulics of Engineering Structures</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>H. Fuchs, I. Albayrak, L. Schmocker</td>
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<tr>
<td>Former Title</td>
<td>Until HS15: Wastewater Hydraulics.</td>
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<tr>
<td>Abstract</td>
<td>Hydraulic fundamentals are applied to hydraulic structures for wastewater, flood protection and hydropower. Typical case studies from engineering practice are further described.</td>
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<tr>
<td>Objective</td>
<td>Understanding and quantification of fundamental hydraulic processes with particular focus on hydraulic structures for wastewater, flood protection and hydropower.</td>
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<tr>
<td>Content</td>
<td>1. Introduction &amp; Basic equations</td>
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<td></td>
<td>2. Losses in flow &amp; Maximum discharge</td>
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<td>3. Uniform flow &amp; Critical flow</td>
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<td>4. Hydraulic jump &amp; Stilling basins</td>
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<td></td>
<td>5. Backwater curves</td>
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<td>6. Weirs/End overfalls &amp; Venturi</td>
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<td></td>
<td>7. Mobile discharge measurements &amp; Culverts/restrictors/inverted siphons</td>
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<td>8. Fall manholes &amp; Vortex drop</td>
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<td></td>
<td>9. Conjunctions &amp; Shock waves at abrupt wall deflections</td>
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<td>10. Air/water flows and bottom outlets</td>
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<td>11. Driftwood retention racks</td>
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<td></td>
<td>12. Vegetated flows - Introduction</td>
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<td></td>
<td>13. Vegetated flows - Application</td>
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<td></td>
<td>14. Summary &amp; questions/preparations for examination</td>
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<tr>
<td>Lecture notes</td>
<td>Text books</td>
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</table>

### Elective Block: Energy

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td>529-0193-00L</td>
<td>Renewable Energy Technologies I</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Wokaun, A. Steinfeld</td>
</tr>
<tr>
<td>Abstract</td>
<td>Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry), Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.</td>
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</table>

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1415 of 1571
Objective

Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content


Prerequisites / notice

Fundamentals of chemistry, physics and thermodynamics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

Lecture notes

Lecture notes will be distributed electronically during the course.

Literature


Abstract

The course provides an introduction to the methods and tools for analysis of energy consumption, energy production and energy flows. Environmental aspects are included as well as economical considerations. Different sectors of the society are discussed, such as electric power, buildings, and transportation. Models for energy system analysis planning are introduced.

Objective

The purpose of the course is to give the participants an overview of the methods and tools used for energy systems analysis and how to use these in simple practical examples.

Content

The course gives an introduction to methods and tools for analysis of energy consumption, energy production and energy flows. Both larger systems, e.g. countries, and smaller systems, e.g. industries, homes, vehicles, are studied. The tools and methods are applied to various problems during the exercises. Different conventions of energy statistics used are introduced.

The course provides also an introduction to energy systems models for developing scenarios of future energy consumption and production. Bottom-up and Top-Down approaches are addressed and their features and applications discussed.

The course contains the following parts:

Part I: Energy flows and energy statistics
Part II: Environmental impacts
Part III: Electric power systems
Part IV: Energy in buildings
Part V: Energy in transportation
Part VI: Energy systems models

Lecture notes

Handouts

Literature


Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Electives ETH Zurich

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Recommended GESS Science in Perspective (Type B) for D-BAUG.

Bachelor’s Thesis

The Bachelor Programme concludes with the Bachelor Thesis. This project is supervised by a professor. Writing up the Bachelor Thesis encourages students to show independence and to produce structured work.

Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

The contents base upon the fundamentals of the Bachelor Programme. Students can choose from different subjects and tasks. The thesis consists of both a written report and an oral presentation.

Environmental Engineering Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>10</td>
<td>20</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Compulsory

Suitable for doctorate

Recommended, not eligible for credits

Courses outside the curriculum
### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
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</table>

### ECTS
- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
Environmental Engineering Master

Master Studies (Programme Regulations 2016)

Majors

Major Urban Water Management

Compulsory Modules

Ecological System Design

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0307-01L</td>
<td>Advanced Environmental, Social and Economic Assessments</td>
<td>O</td>
<td>5 credits</td>
<td>3G</td>
<td>A. E. Braunschweig, S. Hellweg, R. Frischknecht</td>
</tr>
</tbody>
</table>

Abstract
This course deepens students' knowledge of environmental, economic, and social assessment methodologies and their various applications.

Objective
This course has the aim of deepening students' knowledge of the environmental, economic and social assessment methodologies and their various applications.

In particular, students completing the course should have the
- ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- knowledge about the current state of the scientific discussion and new research developments
- ability to properly plan, conduct and interpret environmental assessment studies

In the course element "Implementation of Environmental and other Sustainability Goals", students will learn to
- describe key sustainability problems of the current economic system and measuring units
- describe the management system of an organisation and illustrate how to improve its sustainability management (especially planning and controlling), based on current ISO management standards and additional frameworks
- discuss approaches to measure environmental performance measurement of an organisation, including ‘organisational LCA’ (Ecobalance)
- explain the pros and cons of single score environmental assessment methods
- demonstrate life cycle costing from a sustainability viewpoint
- interpret stakeholder relations of an organisation
- (if time allows) describe sustainable supply chain management

Content
Part I (Advanced Environmental Assessments)
- Inventory database developments, transparency, data quality, data completeness, and data exchange formats, uncertainties
- Software tools (MFA, LCA)
- Allocation (multiooutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Impact assessment of waterborne chemical emissions, sum parameters, mixture toxicity
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Subjectivity in environmental assessments
- Multicriteria Decision Analysis
- Case Studies

Part II (Implementation of Environmental and other Sustainability Goals):
- Sustainability problems of the current economic system and its measuring units;
- The structure of a management system, and elements to integrate environmental management (ISO 14001) and social management (SA8000 as well as ISO 26000), especially into strategy development, planning, controlling and communication;
- Sustainability Opportunities and Innovation
- The concept of Continuous Improvement
- Life Cycle Costing, Life Cycle Management
- Environmental performance measurement of an organisation, including ‘organisational LCA’ (Ecobalance), based on practical examples of companies and new concepts
- Single score env. assessment methods (Swiss ecopoints)
- Stakeholder management and sustainability oriented communication
- an intro into sustainability issues of supply chain management

Students will get small exercises related to course issues.

Lecture notes
Part I: Slides and background reading material will be available on lecture homepage
Part II: Documents will be available on ilias

Literature
Will be made available.

Prerequisites / notice
This course should only be elected by students of environmental engineering with a Module in Ecological Systems Design. All other students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental and other Sustainability goals (with or without exercise and lab).

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students who have not yet had classwork in this topic are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. (2016). Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).

102-0317-00L Advanced Environmental Assessment (Computer Lab) O 1 credit 1U S. Pfister

Abstract
Different tools and software used for environmental assessments, such as LCA are introduced. The students will have hands-on exercises in the computer rooms and will gain basic knowledge on how to apply the software and other resources in practice

Objective
Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.

Process Engineering in Urban Water Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0217-01L</td>
<td>Process Engineering lb</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>E. Morgenroth</td>
</tr>
</tbody>
</table>

Prerequisite: 102-0217-00L Process Engineering Ia (1st half of semester).

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1418 of 1571
Advanced environmental biotechnology for wastewater, waste, and also drinking water treatment. Suspended growth and biofilm based processes. Nitrogen, phosphorus, and sulfur cycle in biological processes. Advanced design and critical evaluation of treatment plants. Mathematical modeling tools, and knowledge obtained from the current literature. The students shall be capable to apply and recognize the limits of the kinetic models which have been developed to simulate these systems.

Students should be able to evaluate existing wastewater treatment plants and future designs using basic process understanding, stoichiometric and conservation. Ideal reactors, residence time distribution, heterogeneous systems, dynamic response of reactors. Parameter identification, local sensitivity, error propagation, Monte Carlo simulation. Introduction to real time control (PID controllers). Extensive coding of examples in Berkeley Madonna.

The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.

The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
- Introduction into modeling and simulation
- The material balance equations, transport processes, transformations (kinetics, stoichiometry, conservation)
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

The students understand the fundamental principles of atmospheric transport, dispersion and chemistry of pollutants on the local to regional scale and their transfer between air and condensed phases (aerosols, water, solids). This includes the knowledge of important atmospheric reactions, sources and sinks. The obtained understanding enables the students to apply computational tools to predict the transport and transformation of chemicals at the local to regional scale.

Module will be offered from FS17 on.

Major Environmental Technologies
Compulsory Modules
Air Quality Control

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0377-00L</td>
<td>Air Pollution Modeling and Chemistry</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>S. Henne, A. C. Gerecke, S. Reimann Bhend</td>
</tr>
</tbody>
</table>

Copies of overheads will be made available.

There will be a required textbook that students need to purchase: Willi Gujer (2008): Systems Analysis for Water Technology. Springer-Verlag, Berlin Heidelberg

This course will be offered together with the course Process Engineering Ia. It is advantageous to follow both courses simultaneously.

Copies of overheads will be made available.

There will be a required textbook that students need to purchase (see http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html for further information).

### System Analysis in Urban Water Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0227-00L</td>
<td>Systems Analysis and Mathematical Modeling in Urban Water Management</td>
<td>O</td>
<td>6</td>
<td>4G</td>
<td>E. Morgenroth, M. Maurer</td>
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### Water Infrastructure Planning and Stormwater Management

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<th>Number</th>
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<tbody>
<tr>
<td>102-0217-00L</td>
<td>Process Engineering Ia</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
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<tr>
<td>102-0227-00L</td>
<td>Process Engineering Ia</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
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<tr>
<td>102-0217-00L</td>
<td>Process Engineering Ia</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
</tr>
</tbody>
</table>

Copies of overheads will be made available.

There will be a required textbook that students need to purchase: Willi Gujer (2008): Systems Analysis for Water Technology. Springer-Verlag, Berlin Heidelberg

This course will be offered together with the course Process Engineering Ia. It is advantageous to follow both courses simultaneously.

Copies of overheads will be made available.

There will be a required textbook that students need to purchase (see http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html for further information).

### Water Infrastructure Planning and Stormwater Management

Module will be offered from FS17 on.

Major Environmental Technologies
Compulsory Modules
Air Quality Control

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0377-00L</td>
<td>Air Pollution Modeling and Chemistry</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>S. Henne, A. C. Gerecke, S. Reimann Bhend</td>
</tr>
</tbody>
</table>

Copies of overheads will be made available.

There will be a required textbook that students need to purchase: Willi Gujer (2008): Systems Analysis for Water Technology. Springer-Verlag, Berlin Heidelberg

This course will be offered together with the course Process Engineering Ia. It is advantageous to follow both courses simultaneously.

Copies of overheads will be made available.

There will be a required textbook that students need to purchase (see http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html for further information).

### System Analysis in Urban Water Management

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>102-0227-00L</td>
<td>Systems Analysis and Mathematical Modeling in Urban Water Management</td>
<td>O</td>
<td>6</td>
<td>4G</td>
<td>E. Morgenroth, M. Maurer</td>
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</tbody>
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### Water Infrastructure Planning and Stormwater Management

Module will be offered from FS17 on.

Major Environmental Technologies
Compulsory Modules
Air Quality Control

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</table>

Copies of overheads will be made available.

There will be a required textbook that students need to purchase: Willi Gujer (2008): Systems Analysis for Water Technology. Springer-Verlag, Berlin Heidelberg

This course will be offered together with the course Process Engineering Ia. It is advantageous to follow both courses simultaneously.
The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:

- Structure of the Atmosphere
- Thermodynamics of the atmosphere
- Atmospheric stability
- Atmospheric boundary layer and turbulence
- Dispersion in the atmospheric boundary layer
- Numerical models of atmospheric dispersion
- Gas phase reaction kinetics
- Tropospheric chemistry and ozone formation
- Chemistry box models
- Volatile organic pollutants (VOCs) and semi-volatile organic pollutants (SVOCs)
- Distribution of chemicals between different phases
- Kinetics of phase transfer processes
- Computational tools to estimate volatility, distribution and phase transfer rates of organic chemicals

Lecture notes

Continued updates of:
- Slides and handouts
- Home assignments and sample solutions
- R package and code for some of the home assignments
- Free software packages for estimation of properties and fate of organic chemicals
- Key journal articles as discussed during lecture

Literature

Atmospheric chemistry

Environmental organic chemistry and mass transfer

Atmospheric modeling

Prerequisites / notice

strongly recommended: 102-0635-01L Luftreinhaltung (Air Pollution Control) or similar

Process Engineering in Urban Water Management

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0217-01L</td>
<td>Process Engineering Ib</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
</tr>
<tr>
<td></td>
<td>Prerequisite: 102-0217-00L Process Engineering Ia (1st half of semester).</td>
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<tr>
<td>Objective</td>
<td>Students should be able to evaluate existing wastewater treatment plants and future designs using basic process understanding, mathematical modeling tools, and knowledge obtained from the current literature. The students shall be capable to apply and recognize the limits of the kinetic models which have been developed to simulate these systems.</td>
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<tr>
<td>Content</td>
<td>Advanced modeling of activated sludge systems</td>
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<tr>
<td></td>
<td>Nitrification, denitrification, and biological P elimination</td>
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<td></td>
<td>Enrichment in mixed culture systems using, e.g., selectors</td>
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<td></td>
<td>Biofilm kinetics and application to full scale plants</td>
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<tr>
<td></td>
<td>Critical review of treatment processes</td>
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<tr>
<td>Lecture notes</td>
<td>Copies of overheads will be made available.</td>
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</tr>
<tr>
<td>Literature</td>
<td>There will be a required textbook that students need to purchase (see <a href="http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-0.html">http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-0.html</a> for further information).</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisite: 102-0217-00 Process Engineering Ia (in first half of semester).</td>
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System Analysis in Urban Water Management

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<th>Number</th>
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<td>O</td>
<td>6</td>
<td>4G</td>
<td>E. Morgenroth, M. Maurer</td>
</tr>
<tr>
<td>Objective</td>
<td>The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.</td>
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<tr>
<td>Content</td>
<td>The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:</td>
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<td></td>
<td>- Introduction into modeling and simulation</td>
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<td></td>
<td>- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)</td>
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<td></td>
<td>- Ideal reactors</td>
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<td></td>
<td>- Hydraulic residence time distribution and modeling of real reactors</td>
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<td></td>
<td>- Dynamic behavior of reactor systems</td>
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<td></td>
<td>- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation</td>
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<td></td>
<td>- Introduction to process control (PID controller, fuzzy control)</td>
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<tr>
<td>Lecture notes</td>
<td>Copies of overheads will be made available.</td>
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<tr>
<td>Literature</td>
<td>There will be a required textbook that students need to purchase: Willi Gujer (2008): Systems Analysis for Water Technology. Springer-Verlag, Berlin Heidelberg</td>
<td></td>
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</tbody>
</table>
Prerequisites / notice
This course will be offered together with the course Process Engineering Ia. It is advantageous to follow both courses simultaneously.

102-0217-00L
Process Engineering Ia
Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion for biogas production and aerobic wastewater treatment.

Objective
Students should be able to evaluate and design biological processes. Develop simple mathematical models to simulate treatment processes.

Content
Stoichiometry
Microbial transformation processes
Introduction to design and modeling of activated sludge processes
Anaerobic processes, industrial applications, sludge stabilization

Lecture notes
Copies of overheads will be made available.

Literature
There will be a required textbook that students need to purchase (see http://www.sww.ifu.ETHZ.ch/studium/vorlesungen/process-engineering-i0.html for further information).

Prerequisites / notice
For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html

▶▶▶▶ Waste Management

Remark: 102-0337-00 Landfilling, Contaminated Sites and Radioactive Waste Repositories only for those students also taking module "System Analysis in Urban Water Management" as replacement of 102-0217-00 Process Engineering Ia in module "Waste Management".

Number Title Type ECTS Hours Lecturers
102-0357-00L Waste Recycling Technologies O 3 credits 2G R. Bunge

Abstract
Waste Recycling Technology (WRT) is sub-discipline of Mechanical Process Engineering. WRT is employed in production plants processing contaminated soil, construction wastes, scrap metal, recovered paper and the like. While WRT is well established in Central Europe, it is only just now catching on in emerging markets as well.

Objective
At the core of this course is the separation of mixtures of solid bulk materials according to physical properties such as color, electrical conductivity, magnetism and so forth. After having taken this course, the students should have concept not only of the unit operations employed in WRT but also of how these unit operations are integrated into the flow sheets of production plants.

Content
Introduction
Waste Recycling: Scope and objectives
Waste recycling technologies in Switzerland
Fundamentals
Properties of particles: Liberation conditions, Particle size and shape, Porosity of bulk materials
Fluid dynamics of particles: Stationary particle beds, Fluidized beds, Free settling particles
Flow sheet basics: Balancing mass flows
Standard processes: batch vs. continuous
Assessment of separation success: Separation function; grade vs. recovery

Lecture notes
The script consists of the transparencies shown during the lectures. Background material will be provided on the script-server.

Literature
A list of recommended books will be provided.

Prerequisites / notice
We will approach this topic from the perspective not of theory, but of practical application. However, solid fundamentals in physics (in particular in mechanics) are strongly recommended.

102-0337-00L Landfilling, Contaminated Sites and Radioactive Waste Repositories

Abstract
Practices of landfilling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim to protect the environment. The assessment of contaminants that may leach into the environment as a function of time and how to reduce the rate of their release is key to the design of chemical, technical and geological barriers.

Objective
Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants
- describe technologies available to minimize environmental contamination
- describe the principles in handling of contaminated sites and to propose and evaluate suitable remediation techniques
- explain the concepts that underlie radioactive waste disposal practices

Content
This lecture course comprises of lectures with exercises and guided case studies.
- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

Lecture notes
Short script plus copies of overheads

Literature
Literature will be made available.

Prerequisites / notice
This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

102-0217-00L Process Engineering Ia
Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion for biogas production and aerobic wastewater treatment.

Objective
Students should be able to evaluate and design biological processes. Develop simple mathematical models to simulate treatment processes.
There will be a required textbook that students need to purchase (see http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-01.html for further information). Copies of overheads will be made available.

For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-01.html

### Major Resource Management

#### Compulsory Modules

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

#### Objective

This course is intended to deepen students' knowledge of environmental, economic, and social assessment methodologies and their various applications. Students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental and other Sustainability Goals.

#### Content

- In particular, students completing the course should have the ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors.
- Knowledge about the current state of the scientific discussion and new research developments.
- Ability to properly plan, conduct and interpret environmental assessment studies.

In the course element “Implementation of Environmental and other Sustainability Goals”, students will learn to:

- Describe key sustainability problems of the current economic system and its measuring units;
- Describe the management system of an organisation and illustrate how to improve its sustainability management (especially planning and controlling), based on current ISO management standards and additional frameworks.
- Discuss approaches to measure environmental performance measurement of an organisation, including ‘organisational LCA’ (Ecobalance).
- Explain the pros and cons of single score environmental assessment methods.
- Demonstrate life cycle costing from a sustainability viewpoint.
- Interpret stakeholder relations of an organisation.
- If time allows: Describe sustainable supply chain management.

#### Lecture notes

- Part I: Slides and background reading material will be available on lecture homepage.
- Part II: Documents will be available on Ilias.

#### Literature

Will be available.

#### Prerequisites / notice

This course should only be elected by students of environmental engineering with a with a Module in Ecological Systems Design. All other students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental and other Sustainability goals (with or without exercise and lab). Basic knowledge of environmental assessment tools is a prerequisite for this class. Students who have not yet had classwork in this topic are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. (2016). Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).

### Ecological System Design

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>102-0317-03L</td>
<td>Advanced Environmental Assessment (Computer Lab I)</td>
<td>O</td>
<td>1</td>
<td>1U</td>
<td>S. Pfister</td>
</tr>
</tbody>
</table>

#### Objective

Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.

### Groundwater

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1422 of 1571
### Waste Management

**Remark:** 102-0337-00 Landfilling, Contaminated Sites and Radioactive Waste Repositories only for those students also taking module "Water Infrastructure Planning and Stormwater Management" as replacement of 102-0217-00 Process Engineering Ia in module "Waste Management".

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<td>102-0357-00L</td>
<td>Waste Recycling Technologies</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>R. Bunge</td>
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<td><strong>Abstract</strong></td>
<td>Waste Recycling Technology (WRT) is sub-discipline of Mechanical Process Engineering. WRT is employed in production plants, processing contaminated soil, construction wastes, scrap metal, recovered paper and the like. While WRT is well established in Central Europe, it is only just now catching on in emerging markets as well.</td>
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<td><strong>Content</strong></td>
<td>Introduction Waste Recycling: Scope and objectives Waste recycling technologies in Switzerland Fundamentals Properties of particles: Liberation conditions, Particle size and shape, Porosity of bulk materials Fluid dynamics of particles: Stationary particle beds, Fluidized beds, Free settling particles Flow sheet basics: Balancing mass flows Standard processes: batch vs. continuous Assessment of separation success: Separation function; grade vs. recovery Separation Process Separation according to size and shape (Classification): Screening, Flow separation Separation according to material properties (Concentration): Manual Sorting, Gravity concentration; Magnetic separation, Eddy current separation, Electrostatic separation, Sensor technology, Froth flotation Lecture notes The script consists of the transparencies shown during the lectures. Background material will be provided on the script-server. Literature A list of recommended books will be provided. Prerequisites / notice We will approach this topic from the perspective not of theory, but of practical application. However, solid fundamentals in physics (in particular in mechanics) are strongly recommended.</td>
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<tr>
<td>102-0337-00L</td>
<td>Landfilling, Contaminated Sites and Radioactive Waste Repositories</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>W. Hummel, L. M. Plötze</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Practices of landfilling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim to protect the environment. The assessment of contaminants that may leach into the environment as a function of time and how to reduce the rate of their release is key to the design of chemical, technical and geological barriers.</td>
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<td><strong>Objective</strong></td>
<td>Upon successful completion of this course students are able to: - assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants - describe technologies available to minimize environmental contamination - describe the principles in handling of contaminated sites and to propose and evaluate suitable remediation techniques - explain the concepts that underlie radioactive waste disposal practices</td>
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<td><strong>Content</strong></td>
<td>This lecture course comprises of lectures with exercises and guided case studies. - A short overview of the principles of environmental protection in waste management and how this is applied in legislation. - A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds - Technical barrier design and function. Clay as a barrier. - Contaminated site remediation: Site evaluation, remediation technologies - Concepts and safety in radioactive waste management - Role of the geological and engineered barriers and radionuclide transport in geological media. Lecture notes Short script plus copies of overheads Literature Literature will be made available. Prerequisites / notice This is an interdisciplinary course aimed at environmental scientists and environmental engineers.</td>
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<td>102-0217-00L</td>
<td>Process Engineering Ia</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion for biogas production and aerobic wastewater treatment.</td>
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<td><strong>Objective</strong></td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Stoichiometry Microbial transformation processes Introduction to design and modeling of activated sludge processes Anaerobic processes, industrial applications, sludge stabilization Lecture notes Copies of overheads will be made available. Literature</td>
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<td>Prerequisites / notice</td>
<td>For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at <a href="http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-0.html">http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-0.html</a> for further information).</td>
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### Water Resources Management

<table>
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<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>P. Burlando, S. Fatichi</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.</td>
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</tbody>
</table>

Lecture notes Parts of the script for "Hydrology I" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

Literature Additional literature is presented during the course.

Major Water Resources Management

Compulsory Modules

Flow and Transport

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>101-0267-01L</td>
<td>Numerical Hydraulics</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Holzner</td>
</tr>
</tbody>
</table>

Abstract In the course Numerical Hydraulics the basics of numerical modelling of flows are presented.

Objective The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.

Content The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

Lecture notes Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

Literature Given in lecture

Groundwater

Module will be offered from FS17 on.

Landscape

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>103-0347-00L</td>
<td>Landscape Planning and Environmental Systems</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>A. Grêt-Regamey</td>
</tr>
</tbody>
</table>

Abstract In the course, methods for the identification and measurement of landscape characteristics, as well as measures and implementation of landscape planning are taught. Landscape planning is put into the context of the environmental systems (soil, water, air, climate, flora and fauna) and discussed with regard to socio-political questions of the future.

Objective The aims of this course are:
1) To illustrate the concept of landscape planning, the economic relevance of landscape and nature in the context of the environmental systems (soil, water, air, climate, flora and fauna).
2) To show landscape planning as an integral information system for the coordination of different instruments by illustrating the aims, methods, instruments and their functions in landscape planning.
3) To show the importance of ecosystem services.
4) To point out basic information about nature and landscape: Analysis and assessment of the complex interactions between landscape elements, effects of existing and foreseeable utilization of space (nature goods and services and landscape functions).
5) To identify and measure the characteristics of landscape.
6) Learn how to use the instrument of GIS appropriately in landscape planning.

Content In this course, the following topics are discussed:
- Definition of the concept of landscape
- Landscape change
- Landscape planning
- Methods, instruments and aims of landscape planning (politics)
- Socio-political questions of the future
- Environmental systems, IUHC Red List, ecological connectivity
- Urban landscape services
- Practice of landscape planning
- Use of GIS in landscape planning

Lecture notes No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.

Prerequisites / notice The contents of the course will be illustrated in the associated lecture 103-0347-01 U (Landscape Planning and Environmental Systems (GIS Exercises)). An combination of courses is recommended.

Water Resources Management

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tbody>
<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Burlando, S. Fatchi</td>
</tr>
</tbody>
</table>

Abstract The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

Objective Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.


Lecture notes Parts of the script for "Hydrology II" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

Literature Additional literature is presented during the course.

Major River and Hydraulic Engineering

Compulsory Modules

Flow and Transport
The lecture addresses the fundamentals to quantitatively describe the flow of water, the transport of sediments and morphological changes. The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.

The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partly are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

**Hydraulic Engineering**

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0247-01L</td>
<td>Hydraulic structures II</td>
<td>O</td>
<td>6</td>
<td>4G</td>
<td>R. Boes</td>
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</table>

**River Systems**

Remark: partly in German.

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0258-00L</td>
<td>River Engineering</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>G. R. Bezzola</td>
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</table>

**Water Resources Management**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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</table>
Lecture notes
Parts of the script for "Hydrology I" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

Literature
Additional literature is presented during the course.

Elective Modules
For all majors.

EM: Air Quality Control
Elective Module for Majors "Resource Management", "River and Hydraulic Engineering" "Urban Water Management" and "Water Resources Management".

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<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>102-0377-00L</td>
<td>Air Pollution Modeling and Chemistry</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Henne, A. C. Gerecke, S. Reimann Bhend</td>
</tr>
</tbody>
</table>

Abstract
Air pollutants cause negative effects on humans, wildlife and buildings. To control and reduce the impact of air pollutants, their transfer from sources to receptors needs to be known. This transfer includes transport within the atmospheric boundary layer, chemical transformation reactions and phase-transfer processes from air to liquid and solid materials (aerosols, water, ...).

Objective
The students understand the fundamental principles of atmospheric transport, dispersion and chemistry of pollutants on the local to regional scale and their transfer between air and condensed phases (aerosols, water, solids). This includes the knowledge of important atmospheric reactions, sources and sinks. The obtained understanding enables the students to apply computational tools to predict the transport and transformation of chemicals at the local to regional scale.

Content
- Structure of the Atmosphere
- Thermodynamics of the atmosphere
- Atmospheric stability
- Atmospheric boundary layer and turbulence
- Dispersion in the atmospheric boundary layer
- Numerical models of atmospheric dispersion
- Gas phase reaction kinetics
- Tropospheric chemistry and ozone formation
- Chemistry box models
- Volatile organic pollutants (VOCs) and semi-volatile organic pollutants (SVOCs)
- Distribution of chemicals between different phases
- Kinetics of phase transfer processes
- Computational tools to estimate volatility, distribution and phase transfer rates of organic chemicals

Lecture notes
Continued updates of:
- Slides and handouts
- Home assignments and sample solutions
- R package and code for some of the home assignments
- Free software packages for estimation of properties and fate of organic chemicals
- Key journal articles as discussed during lecture

Literature
Atmospheric chemistry

Environmental organic chemistry and mass transfer
Mackay D., Multimedia environmental models : the fugacity approach; Boca Raton, Fla. : Lewis Publishers; 2001; 2nd ed

Atmospheric dynamics and boundary layer

Atmospheric modelling

Introduction to R

Prerequisites / notice
strongly recommended: 102-0635-01L Luftreinhaltung (Air Pollution Control) or similar

EM: Ecological System Design
Elective Module for Majors "Environmental Technologies", "River and Hydraulic Engineering" and "Water Resources Management".

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<th>Hours</th>
<th>Lecturers</th>
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</table>

Abstract
This course deepens students' knowledge of environmental, economic, and social assessment methodologies and their various applications.
Objective
This course has the aim of deepening students' knowledge of the environmental, economic and social assessment methodologies and their various applications.

In particular, students completing the course should have the
- ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- knowledge about the current state of the scientific discussion and new research developments
- ability to properly plan, conduct and interpret environmental assessment studies

In the course element "Implementation of Environmental and other Sustainability Goals", students will learn to
- describe key sustainability problems of the current economic system and measuring units.
- describe the management system of an organisation and illustrate how to improve its sustainability management (especially planning and controlling), based on current ISO management standards and additional frameworks.
- discuss approaches to measure environmental performance measurement of an organisation, including ‘organisational LCA’ (Ecobalance)
- explain the pros and cons of single score environmental assessment methods
- demonstrate life cycle costing from a sustainability viewpoint
- interpret stakeholder relations of an organisation
- (if time allows) describe sustainable supply chain management

Content
Part I (Advanced Environmental Assessments)
- Inventory database developments, transparency, data quality, data completeness, and data exchange formats, uncertainties
- Software tools (MFA, LCA)
- Allocation (multioutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Impact assessment of waterborne chemical emissions, sum parameters, mixture toxicity
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Subjectivity in environmental assessments
- Multicriteria Decision Analysis
- Case Studies

Part II (Implementation of Environmental and other Sustainability Goals):
- Sustainability problems of the current economic system and its measuring units;
- The structure of a management system, and elements to integrate environmental management (ISO 14001) and social management (SA8000 as well as ISO 26000), especially into strategy development, planning, controlling and communication;
- Sustainability Opportunities and Innovation
- The concept of ‘Continuous Improvement’
- Life Cycle Costing, Life Cycle Management
- environmental performance measurement of an organisation, including ‘organisational LCA’ (Ecobalance), based on practical examples of companies and new concepts
- single score env. assessment methods (Swiss ecopoints)
- stakeholder management and sustainability oriented communication
- an intro into sustainability issues of supply chain management

Students will get small exercises related to course issues.

Lecture notes
Part I: Slides and background reading material will be available on lecture homepage
Part II: Documents will be available on Ilias

Literature
Will be made available.

Prerequisites / notice
This course should only be elected by students of environmental engineering with a with a Module in Ecological Systems Design. All other students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental and other Sustainability goals (with or without exercise and lab).

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students who have not yet had classwork in this topic are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. (2016). Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).

102-0317-03L Advanced Environmental Assessment (Computer Lab W 1 credit 1U S. Pfister

Abstract
Different tools and software used for environmental assessments, such as LCA are introduced. The students will have hands-on exercises in the computer rooms and will gain basic knowledge on how to apply the software and other resources in practice

Objective
Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.

>>> EM: Flow and Transport
Elective Module for Majors “Environmental Technologies”, “Resource Management” and “Urban Water Management”.

Number
Title
Type ECTS Hours Lecturers

101-0267-01L Numerical Hydraulics W 3 credits 2G M. Holzner

Objective
The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.

Content
The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

Lecture notes
Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

Literature
Given in lecture

>>> EM: Groundwater
Elective Module for Majors “Environmental Technologies”, “River and Hydraulic Engineering” and “Urban Water Management”.

Module will be offered from FS17 on.
EM: Hydraulic Engineering


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<tbody>
<tr>
<td>101-0247-01L</td>
<td>Hydraulic structures II</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>R. Boes</td>
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</tbody>
</table>

**Abstract**

Hydraulic structures and their function within a hydraulic scheme are explained. The basic concepts of their layout and design with regard to economy and safety are provided.

**Objective**

Knowledge of hydraulic structures and their function within a hydraulic scheme. Skills for the layout and design of hydraulic structures with regard to economy and safety.

**Content**

- Weirs: Weir stability, gates, inflatable dams, appurtenant structures.
- Conduits: Design of headraces, pressure shafts, and penstocks, constructive details and construction.
- Power plants: Power house and turbine types, design, structure, construction.
- Dams: Dam types, appurtenant structures (diversion, spillways, bottom outlet), dam type selection criteria, layout and design of gravity dams, buttress dams, arch dams, rockfill dams with central core or concrete face, measures in the foundation, mass concrete, RCC dams, reservoir siltation and sediment management, dam surveillance.
- Artificial reservoirs: Purpose, layout, sealing, appurtenant structures, environmental aspects.

Lecture notes and Literature is specified in the lecture and in the manuscript.

**Prerequisites**

Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).

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EM: Landscape

**Elective Module for Majors "Environmental Technologies", "Resource Management", "River and Hydraulic Engineering" and "Urban Water Management".

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<tbody>
<tr>
<td>103-0347-00L</td>
<td>Landscape Planning and Environmental Systems</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>A. Grêt-Regamey</td>
</tr>
</tbody>
</table>

**Abstract**

In the course, methods for the identification and measurement of landscape characteristics, as well as measures and implementation of landscape planning are taught. Landscape planning is put into the context of the environmental systems (soil, water, air, climate, flora and fauna) and discussed with regard to socio-political questions of the future.

**Objective**

The aims of this course are:

1. To illustrate the concept of landscape planning, the economic relevance of landscape and nature in the context of the environmental systems (soil, water, air, climate, flora and fauna).
2. To show landscape planning as an integral information system for the coordination of different instruments by illustrating the aims, methods, instruments and their functions in landscape planning.
3. To show the importance of ecosystem services.
4. To point out basic information about nature and landscape: Analysis and assessment of the complex interactions between landscape elements, effects of existing and foreseeable utilization of space (nature goods and services and landscape functions).
5. To identify and measure the characteristics of landscape.
6. Learn how to use the instrument of GIS appropriately in landscape planning.

**Content**

In this course, the following topics are discussed:

1. Definition of the concept of landscape
2. Landscape change
3. Landscape planning
4. Methods, instruments and aims of landscape planning (politics)
5. Socio-political questions of the future
6. Environmental systems, IUCN Red List, ecological connectivity
7. Urban landscape services
8. Practice of landscape planning
9. Use of GIS in landscape planning

**Lecture notes**

No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.

**Prerequisites**

The contents of the course will be illustrated in the associated lecture 103-0347-01 U (Landscape Planning and Environmental Systems (GIS Exercises)). An combination of courses is recommended.

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EM: Process Engineering in Urban Water Management

**Elective Module for Majors "Resource Management", "River and Hydraulic Engineering" and "Water Resources Management".

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</thead>
<tbody>
<tr>
<td>102-0217-01L</td>
<td>Process Engineering Ia</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
</tr>
</tbody>
</table>

Prerequisite: 102-0217-00L Process Engineering Ia (1st half of semester).

**Abstract**


**Objective**

Students should be able to evaluate existing wastewater treatment plants and future designs using basic process understanding, mathematical modeling tools, and knowledge obtained from the current literature. The students shall be capable to apply and recognize the limits of the kinetic models which have been developed to simulate these systems.

**Content**

- Advanced modeling of activated sludge systems
- Nitrification, denitrification, and biological P elimination
- Enrichment in mixed culture systems using, e.g., selectors
- Biofilm kinetics and application to full scale plants
- Critical review of treatment processes

**Lecture notes**

Copies of overheads will be made available.

**Literature**

There will be a required textbook that students need to purchase (see http://www.sww.itu.ethz.ch/studium/vorlesungen/process-engineering-i0.html for further information).
EM: Remote Sensing and Earth Observation


**Prerequisite:** 102-0217-00 Process Engineering Ia (in first half of semester).

**Remarks:** Students also taking module “Remote Sensing and Earth Observation” as replacement of 102-0617-01L Methodologies for Image Processing of Remote Sensing Data in module “Landscape” have to choose one out following list:

1. 701-0104-00L Statistical Modelling of Spatial Data (FS) oder 701-1674-00L Spatial Analysis, Modelling and Optimisation (FS) oder 701-1644-00L Mountain Forest Hydrology (HS).

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<tbody>
<tr>
<td>102-0617-00L</td>
<td>Basics and Principles of Radar Remote Sensing for Environmental Applications</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>I. Hajnsek</td>
</tr>
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</table>

**Abstract**
The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

**Objective**
The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. At the end of the course the student has the understanding of:

1. SAR basics and principles
2. SAR polarimetry
3. SAR interferometry and
4. environmental parameter estimation from multi-parametric SAR data

**Content**
The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:

1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

**Lecture notes**
Handouts for each topic will be provided.

**Literature**
First readings for the course:
Complete literature listing will be provided during the course.

EM: River Systems


<table>
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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>101-0258-00L</td>
<td>River Engineering</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>G. R. Bezzola</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture addresses the fundamentals to quantitatively describe the flow of water, the transport of sediments and morphological changes like erosion or deposition in watercourses. Further addressed are the design and dimensioning of river engineering works to create and ensure sufficient capacity, channel stability as well as to ensure the ecological functions of the watercourse.

**Objective**
The students shall

- be able to describe the interrelation between discharge, sediment transport and channel evolution quantitatively
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration
- be capable to design and dimension river engineering works needed to influence the processes in watercourses

**Content**
The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, initiation of erosion as well as sediment transport (bed load, suspended load) are treated.

In the second part of the lecture, the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formation and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of channel stability, bed forms, river morphology and scour. The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics focussed on are the stabilization of banks and of the longitudinal profile of rivers.

**Lecture notes**
Lecture notes “River Engineering” (in German, 470 pages, including list of references)

**Literature**
The lecture notes contain a comprehensive list of references for further reading.

**Prerequisites / notice**
Strongly recommended lectures:
Hydrology (102-0293-AAL), Hydraulics I (101-0203-01L) and Hydraulic Engineering (101-0206-00L)

**Prerequisite:** 102-0217-00 Process Engineering Ia (in first half of semester).

A practical exercise (voluntary, unmarked) is offered to deepen the learned subjects.
This exercise bases on field data, which are partly collected by the students on a river in nature. Besides the collection of fundamentals and field data, the exercise comprehends the calculation of the stage-discharge relationship, of the critical discharges for initiation of bed load transport and bed erosion and of the annual sediment load in a given river reach.

EM: Soil


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<tr>
<td>701-0535-00L</td>
<td>Environmental Soil Physics/Vadose Zone Hydrology</td>
<td>W</td>
<td>3 credits</td>
<td>2G+2U</td>
<td>D. Or</td>
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</tbody>
</table>
Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design
The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils.

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller

A. Keller

Lecturers

Type

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media Units and dimensions, definitions and basic mass-volume relationships
properties between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpirationtime coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Lecture notes

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)
http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature

Supplemental textbook (not mandatory) -Environmental Soil Physics, by: D. Hillel

ECTS

701-1681-00L  Element Balancing and Soil Functions in Managed Ecosystems  W  3 credits  2G  A. Keller

Number

3 credits

Abstract

Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures.

Objective

The students learn to critical assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.

Content

The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. You assess the sustainability of current land use and analyse management options improving nutrient and metal cycling in agro-ecosystems. The students will have the opportunity to calculate specific scenarios regarding land use management and environmental changes. Special focus we be paid on the soil functions such as regulation-, production function and soil as habitat, and the assessment of preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures.

Lecture notes

Literature

Literature will be provided.

Prerequisites / notice

The course consists of lectures and computer exercises. The course takes place every 2 weeks à 4 hours. recommended prerequisites for attending this course:
- Bodenschutz und Landnutzung
- Biochemistry of Trace Elements
- Angewandte Bodenökologie

EM: System Analysis in Urban Water Management

Elective Module for Majors "Resource Management", "River and Hydraulic Engineering" and "Water Resources Management".

Number

Title

Type

ECTS

Hours

Lecturers

102-0227-00L Systems Analysis and Mathematical Modeling in Urban Water Management  W  6 credits  4G  E. Morgenroth, M. Maurer

Data: 06.11.2018 12:57

Autumn Semester 2016

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Abstract
Systematic introduction of material balances, transport processes, kinetics, stoichiometry and conservation. Ideal reactors, residence time
distribution, heterogeneous systems, dynamic response of reactors. Parameter identification, local sensitivity, error propagation, Monte
Carlo simulation. Introduction to real time control (PID controllers). Extensive coding of examples in Berkeley Madonna.

Objective
The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan
experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water
management.

Content
The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
- Introduction into modeling and simulation
- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
- Ideal reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

Lecture notes
Copies of overheads will be made available.

Literature

Prerequisites / notice
This course will be offered together with the course Process Engineering Ia. It is advantageous to follow both courses simultaneously.

102-0217-00L Process Engineering Ia W 3 credits 2G E. Morgenroth

Abstract
Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental
principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion
for biogas production and aerobic wastewater treatment.

Objective
Students should be able to evaluate and design biological processes. Develop simple mathematical models to simulate treatment
processes.

Content
Stoichiometry
Microbial transformation processes
Introduction to design and modeling of activated sludge processes
Anaerobic processes, industrial applications, sludge stabilization

Lecture notes
Copies of overheads will be made available.

Literature
For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should
consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at
http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html

Prerequisites / notice
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consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at
http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html

EM: Waste Management
Elective Module for Majors "River and Hydraulic Engineering" "Urban Water Management" and "Water Resources Management".

Remark: 102-0337-00 Landfilling, Contaminated Sites and Radioactive Waste Repositories only for those students also taking module "System Analysis in Urban Water Management" as replacement of 102-0217-00 Process Engineering Ia in module "Waste Management".

Number Title Type ECTS Hours Lecturers
102-0217-00L Process Engineering Ia W 3 credits 2G E. Morgenroth

Abstract
Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental
principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion
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http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html

102-0337-00L Landfilling, Contaminated Sites and Radioactive Waste Repositories W 3 credits 2G W. Hummel, L. M. Plötz

Abstract
Practices of landfilling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim
to protect the environment. The assessment of contaminants that may leach into the environment as a function of time and how to reduce
the rate of their release is key to the design of chemical, technical and geological barriers.

Objective
Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport
of contaminants
- describe technologies available to minimize environmental contamination
- describe the principles in handling of contaminated sites and to propose and evaluate suitable remediation techniques
- explain the concepts that underlie radioactive waste disposal practices
- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive
waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

Lecture notes
Short script plus copies of overheads

Literature
Literature will be made available.

Prerequisites / notice
This is an interdisciplinary course aimed at environmental scientists and environmental engineers.
Waste Recycling Technologies

W 3 credits 2G R. Bunge

Abstract
Waste Recycling Technology (WRT) is sub-discipline of Mechanical Process Engineering. WRT is employed in production plants processing contaminated soil, construction wastes, scrap metal, recovered paper and the like. While WRT is well established in Central Europe, it is only just now catching on in emerging markets as well.

Objective
At the core of this course is the separation of mixtures of solid bulk materials according to physical properties such as color, electrical conductivity, magnetism and so forth. After having taken this course, the students should have concept not only of the unit operations employed in WRT but also of how these unit operations are integrated into the flow sheets of production plants.

Content
Introduction
Waste Recycling: Scope and objectives
Waste recycling technologies in Switzerland

Fundamentals
Properties of particles: Liberation conditions, Particle size and shape, Porosity of bulk materials
Fluid dynamics of particles: Stationary particle beds, Fluidized beds, Free settling particles
Flow sheet basics: Balancing mass flows
Standard processes: batch vs. continuous
Assessment of separation success: Separation function; grade vs. recovery

Separation Process
Separation according to size and shape (Classification): Screening, Flow separation
Separation according to material properties (Concentration): Manual Sorting, Gravity concentration; Magnetic separation, Eddy current separation, Electrostatic separation, Sensor technology, Froth flotation

Lecture notes
The script consists of the transparencies shown during the lectures. Background material will be provided on the script-server.

Literature
A list of recommended books will be provided.

Prerequisites / notice
We will approach this topic from the perspective not of theory, but of practical application. However, solid fundamentals in physics (in particular in mechanics) are strongly recommended.

EM: Water Infrastructure Planning and Stormwater Management

Elective Module for Majors "Environmental Technologies", "Resource Management", "River and Hydraulic Engineering" and "Water Resources Management".

Module will be offered from FS17 on.

EM: Water Resources Management

Elective Module for Majors "Environmental Technologies", and "Urban Water Management".

Specialized Computer Laboratory

Supplementary course to 102-0527-00L Experimental and Computer Laboratory I

Only for Environmental Sciences MSc.

This is a supplementary course for students in the Laboratory Courses in Environmental Engineering who wish to complete all the exercises in Landscape planning and environmental system, as in the 3CP course 103-
Supplement course to the Lab. Courses in Environmental Engineering. Methods for the identification and measurement of landscape characteristics, as well as measures and implementation of landscape planning are deepened. Landscape planning is put into the context of the environment, systems (soil, water, air, climate, flora and fauna) and discussed with regard to socio-political questions of the future.

Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Master Studies (Programme Regulations 2006)

Major Courses

Major in Water Resources Management

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>P. Burlando, S. Fatici</td>
</tr>
</tbody>
</table>

Abstract

The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

Objective

Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.

Content


Lecture notes

Parts of the script for "Hydrology I" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

Literature

Additional literature is presented during the course.

<table>
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<tbody>
<tr>
<td>102-0207-00L</td>
<td>Numerical Hydraulics</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Holzner</td>
</tr>
</tbody>
</table>

Abstract

In the course Numerical Hydraulics the basics of numerical modelling of flows are presented.

Objective

The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.

Content

The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

Lecture notes

All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

Literature

Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

<table>
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<td>Process Engineering Ia</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
</tr>
</tbody>
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Abstract

Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion for biogas production and aerobic wastewater treatment.

Objective

Students should be able to evaluate and design biological processes. Develop simple mathematical models to simulate treatment processes.

Content

Stoichiometry

Microbial transformation processes

Introduction to design and modeling of activated sludge processes

Anaerobic processes, industrial applications, sludge stabilization

Prerequisites / notice

Prerequisites: Hydrology 1 and Hydrology 2 (or contact instructor).

Major in Urban Water Management

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>102-0227-00L</td>
<td>Systems Analysis and Mathematical Modeling in</td>
<td>O</td>
<td>6</td>
<td>4G</td>
<td>E. Morgenroth, M. Maurer</td>
</tr>
</tbody>
</table>
Urban Water Management


Objective  The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.

Content  The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
- Introduction into modeling and simulation
- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

Lecture notes  Copies of overheads will be made available.

Literature  There will be a required textbook that students need to purchase:

Prerequisites / notice  This course will be offered together with the course Process Engineering Ia. It is advantageous to follow both courses simultaneously.

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Objective  Students that choose either combination 2 or 3 and have Urban Water Management as a second Major need to take course "102-0337-00L Landfilling, Contaminated Sites and Radioactive Waste Repositories" (offered in spring semester) instead of "102-0217-00L Process Engineering I (Biological Processes)."

Number  Title  Type  ECTS  Hours  Lecturers
102-0217-00L  Process Engineering Ia  O  3 credits  2G  E. Morgenroth

Abstract  Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion for biogas production and aerobic wastewater treatment.

Objective  Students should be able to evaluate and design biological processes. Develop simple mathematical models to simulate treatment processes.

Content  Stoichiometry
- Microbial transformation processes
- Introduction to design and modeling of activated sludge processes
- Anaerobic processes, industrial applications, sludge stabilization

Lecture notes  Copies of overheads will be made available.

Literature  There will be a required textbook that students need to purchase (see http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html for further information).

Prerequisites / notice  For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html

102-0307-01L  Advanced Environmental, Social and Economic Assessments

Abstract  This course deepens students' knowledge of environmental, economic, and social assessment methodologies and their various applications.

Objective  This course has the aim of deepening students' knowledge of the environmental, economic and social assessment methodologies and their various applications.

In particular, students completing the course should have the
- ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- knowledge about the current state of the scientific discussion and new research developments
- ability to properly plan, conduct and interpret environmental assessment studies

In the course element "Implementation of Environmental and other Sustainability Goals", students will learn to
- describe key sustainability problems of the current economic system and measuring units
- describe the management system of an organisation and illustrate how to improve its sustainability management (especially planning and controlling), based on current ISO management standards and additional frameworks.
- discuss approaches to measure environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance)
- explain the pros and cons of single score environmental assessment methods
- demonstrate life cycle costing from a sustainability viewpoint
- interpret stakeholder relations of an organisation
- (if time allows) describe sustainable supply chain management

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Waste Recycling Technology (WRT) is a sub-discipline of Mechanical Process Engineering. WRT is employed in production plants to manage waste materials. Air pollutants cause negative effects on humans, wildlife, and buildings. To control and reduce the impact of air pollutants, their transfer from sources to receptors needs to be known. This transfer includes transport within the atmospheric boundary layer, chemical transformation reactions and phase-transfer processes from air to liquid and solid materials (aerosols, water, solids).

The students understand the fundamental principles of atmospheric transport, dispersion and chemical processes of pollutants on the local to regional scale and their transfer between air and condensed phases (aerosols, water, solids). This includes the knowledge of important atmospheric reactions, sources and sinks. The obtained understanding enables the students to apply computational tools to predict the transport and transformation of chemicals at the local to regional scale.

Objective

Students will get small exercises related to course issues. Lecture notes

Part I: Slides and background reading material will be available on the lecture homepage. Literature

Will be made available. Prerequisites / notice

This course should only be elected by students of environmental engineering with a Module in Ecological Systems Design. All other students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental and other Sustainability goals (with or without exercise and lab).

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students who have not yet had classwork in this topic are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. (2016). Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).
Upon successful completion of this course students are able to:
- Structure of the Atmosphere
- Thermodynamics of the atmosphere
- Atmospheric stability
- Atmospheric boundary layer and turbulence
- Dispersion in the atmospheric boundary layer
- Numerical models of atmospheric dispersion
- Gas phase reaction kinetics
- Tropospheric chemistry and ozone formation
- Chemistry box models
- Volatile organic pollutants (VOCs) and semi-volatile organic pollutants (SVOCs)
- Distribution of chemicals between different phases
- Kinetics of phase transfer processes
- Computational tools to estimate volatility, distribution and phase transfer rates of organic chemicals

Lecture notes
Continued updates of:
- Slides and handouts
- Home assignments and sample solutions
- R package and code for some of the home assignments
- Free software packages for estimation of properties and fate of organic chemicals
- Key journal articles as discussed during lecture

Literature
Atmospheric chemistry

Environmental organic chemistry and mass transfer
Mackay D., Multimedia environmental models : the fugacity approach; Boca Raton, Fla.: Lewis Publishers; 2001; 2nd ed

Atmospheric dynamics and boundary layer

Atmospheric modelling

Prerequisites / notice
This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

102-0337-00L Landfilling, Contaminated Sites and Radioactive Waste Repositories  

Abstract
Practices of landfilling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim to protect the environment. The assessment of contaminants that may leach into the environment as a function of time and how to reduce the rate of their release is key to the design of chemical, technical and geological barriers.

Objective
- Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants
- describe technologies available to minimize environmental contamination
- describe the principles in handling of contaminated sites and to propose and evaluate suitable remediation techniques
- explain the concepts that underlie radioactive waste disposal practices

Content
This lecture course comprises of lectures with exercises and guided case studies.
- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

Lecture notes
Short script plus copies of overheads

Literature
Literature will be made available.

102-0337-02L Landfilling, Contaminated Sites and Radioactive Waste Repositories

Abstract
Practices of landfilling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim to protect the environment. The assessment of contaminants that may leach into the environment as a function of time and how to reduce the rate of their release is key to the design of chemical, technical and geological barriers.

Objective
Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants
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- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

Lecture notes
Short script plus copies of overheads

Literature
Literature will be made available.

Automatically generated by a language model. Further refinement may be possible.
The lecture notes contain a comprehensive list of references for further reading.

**102-0617-00L Basics and Principles of Radar Remote Sensing for Environmental Applications**

**Abstract**
The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

**Objective**
The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. At the end of the course the student has the understanding of:

1. SAR basics and principles,
2. SAR polarimetry,
3. SAR interferometry and
4. environmental parameter estimation from multi-parametric SAR data

**Content**
The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:

1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

**Lecture notes**
Handouts for each topic will be provided

**Literature**
First readings for the course:
Complete literature listing will be provided during the course.

**101-0258-00L River Engineering**

**Abstract**
The lecture addresses the fundamentals to quantitatively describe the flow of water, the transport of sediments and morphological changes like erosion or deposition in watercourses. Further addressed are the design and dimensioning of river engineering works to create and ensure sufficient capacity, channel stability as well as to ensure the ecological functions of the watercourse.

**Objective**
The students shall:
- be able to describe the interrelation between discharge, sediment transport and channel evolution quantitatively
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration
- be capable to design and dimension river engineering works needed to influence the processes in watercourses

**Content**
The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, initiation of erosion as well as sediment transport (bed load, suspended load) are treated. In the second part of the lecture, the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formation and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of channel stability, bed forms, river morphology and scour. The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics focussed on are the stabilization of banks and of the longitudinal profile of rivers.

**Lecture notes**
Lecture notes "River Engineering" (in German, 470 pages, including list of references)

**Literature**
The lecture notes contain a comprehensive list of references for further reading.

**Prerequisites / notice**
Strongly recommended lectures:
Hydrology (102-0293-AAL), Hydraulics I (101-0203-01L) and Hydraulic Engineering (101-0206-00L)

A practical exercise (voluntary, unmarked) is offered to deepen the learned subjects.
This exercise bases on field data, which are partly collected by the students on a river in nature. Besides the collection of fundamentals and field data, the exercise comprehends the calculation of the stage-discharge relationship, of the critical discharges for initiation of bed load transport and bed erosion and of the annual sediment load in a given river reach.

### Major in Soil Protection

As replacement of 101-0314-99 Soil Mechanics, one of following three courses is compulsory for students of major Soil Protection:

1. 651-4033-00 Soil Mechanics and Foundation (HS), or
2. 751-3404-00L Nutrient Fluxes in Soil-Plant Systems (FS), or
3. 701-1802-00L Ökologie von Waldböden (FS),

#### Number

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<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology</td>
<td>O</td>
<td>3</td>
<td>2G+2U</td>
</tr>
</tbody>
</table>

**Abstract**
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

**Objective**
Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges
### Content

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media  Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:

- Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.
- Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.
- Midterm exam

- Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.
- Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:

- Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.
- Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

### Lecture notes

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)

http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

### Literature

Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

### 701-1315-00L

Biogeochemistry of Trace Elements

<table>
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<th>Objective</th>
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<tbody>
<tr>
<td>The students are familiar with the chemical characteristics, the environmental behavior and fate, and the biogeochemical reactivity of different groups of trace elements. They are able to apply their knowledge on the interaction of trace elements with geosphere components and on abiotic and biotic transformation processes of trace elements to discuss and evaluate the behavior and impact of trace elements in aquatic and terrestrial systems.</td>
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</table>

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>(i) Definition, importance and biogeochemical classification of trace elements. (ii) Key biogeochemical processes controlling the cycling of different trace elements (base metals, redox-sensitive and chalcophile elements, volatile trace elements) in natural and engineered environments. (iii) Abiotic and biotic processes that determine the environmental fate and impact of selected trace elements.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lecture notes / notice</th>
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</thead>
<tbody>
<tr>
<td>Selected handouts (lecture notes, literature, exercises) will be distributed during the course.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
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<tbody>
<tr>
<td>Students are expected to be familiar with the basic concepts of aquatic and soil chemistry covered in the respective classes at the bachelor level (soil mineralogy, soil organic matter, acid-base and redox reactions, complexation and sorption reactions, precipitation/dissolution reactions, thermodynamics, kinetics, carbonate buffer system). This lecture is a prerequisite for attending the laboratory course &quot;Trace elements laboratory&quot;.</td>
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### 701-1681-00L

Element Balancing and Soil Functions in Managed Ecosystems

<table>
<thead>
<tr>
<th>Abstract</th>
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<tbody>
<tr>
<td>Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objective</th>
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<tbody>
<tr>
<td>The students learn to critically assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. You assess the sustainability of current land use and analyse management options improving nutrient and metal cycling in agro-ecosystems. The students will have the opportunity to calculate specific scenarios regarding land use management and environmental changes. Special focus we be paid on the soil services such as regulation-, production function and soil as habitat, and the assessment of these functions based on soil mapping data.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lecture notes / Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature and Exercises for a case study Literature will be provided.</td>
</tr>
</tbody>
</table>

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1438 of 1571
The course presents the principles of soil mechanics and soil behaviour characteristics and its applications in geotechnical structures and systems. It is based on more descriptive courses on Engineering Geology within the BSc Geol. Program and is a compulsory prerequisite for other courses within the MSc Eng. Geol. program.

Objective
Understanding the principles of soil behaviour and the fundamentals of geotechnical practices in soils.

Content
Soil Mechanics:
- Fundamental concepts of strength and deformation of different soils. Introduction to geotechnical calculations
- Significance of (ground)water
- Geotechnical Engineering in Soils:
- Evaluation of geotechnical scenarios, handling of forecast uncertainties, relation of soil properties and soil composition, interactions between soil and building,
- standard construction methods in soils (foundations, slopes, dams and levees),
- requirements for the geotechnical prognosis

Lecture notes
This lecture is supported by the textbook: "Geotechnical Engineering" by Donald P. Coduto, 2nd edition, 2011; ISBN-13: 978-0-13-135425-8

Prerequisites / notice
Courses must be completed:
- Introduction to Engineering Geology (BSc level)
- Introduction to Groundwater
- Sedimentology and Quaternary deposits
- Principles of Physics

Courses recommended:
- Eng Geol Site Investigations
- Eng Geol Field Course I (soils)
- Clay Mineralogy

Specialized Computer Laboratory

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0527-00L</td>
<td>Experimental and Computer Laboratory I (Year Course)</td>
<td>O</td>
<td>0</td>
<td>6P</td>
<td>D. Braun, L. Bioley, N. Derlon, P. U. Lehmann Grunder, B. Lüthi, C. Paschmann, S. Pflister, A. Siviglia, A. Strith, D. F. Vetsch</td>
</tr>
</tbody>
</table>

Abstract
In the Experimental and Computer Laboratory students are introduced to research and good scientific practice. Experiments are conducted in different disciplines of environmental engineering. Data collected during experiments are compared to the corresponding numeric simulations. The results are documented in reports or presentations.

Objective
The student will learn the following skills: basic scientific work, planning and conducting scientific experiments, uncertainty estimations of measurements, applied numerical simulations, modern sensor technology, writing reports.

Content
The Experimental and Computer Laboratory is building on courses in the corresponding modules. Material from these courses is a prerequisite or co-requisite (as specified below) for participating in the Experimental and Computer Laboratory (MODULE: Project in the Experimental and Computer Laboratory):
- AIR: Air Quality Measurements
- WASTE: Anaerobic Digestion
- ESD: Environmental Assessment
- GROUND: Groundwater Field Course Kappelen
- WRM: Modelling Optimal Water Allocation
- FLOW: 1D Open Channel Flow Modelling
- LAND: Landscape Planning and Environmental Systems
- RIVER: Discharge Measurements
- HydEngr: Hydraulic Experiments
- RemSens: Microwave Measurements
- SOIL: Soil and Environmental Measurements Lab

Lecture notes
Written material will be available.

Minors

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0227-00L</td>
<td>Systems Analysis and Mathematical Modeling in Urban Water Management</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>E. Morgenroth, M. Maurer</td>
</tr>
</tbody>
</table>

Abstract

Objective
The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.

Content
The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
- Introduction into modeling and simulation
- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

Lecture notes
Copies of overheads will be made available.

Literature
There will be a required textbook that students need to purchase:

Prerequisites / notice
This course will be offered together with the course Process Engineering Ia. It is advantageous to follow both courses simultaneously.
Handouts are available.

Different selected topics in hydraulic engineering will be focused on, e.g. dam safety, possible problems at reservoirs like sedimentation or erosion, and the effect of impoundments on fisheries. Copies of overheads will be made available.

To understand the fundamental physical processes in glaciology.

Basics in physical glaciology

Lecture notes/handouts will be available online.

Selected Topics on Hydraulic Engineering

The course has two fundamental aims: (1) it aims to provide environmental engineers with the physical process basis of fluvial system interactions, flow of glaciers and ice sheets, and the role of glaciers in the climate system; and (2) it aims to provide quantitative skills in making simple and more complex predictions of change and the data and models required.

Prerequisites / notice

Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).

Lecture notes

is specified in the lecture and in the manuscript

Literature

External speakers will present current topics and projects in Switzerland and abroad.

Applied Glaciology

We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

Objective

To understand the fundamental physical processes in glaciology.

To learn some basic numerical modelling techniques for glacier flow.

To identify glaciological hazards and to learn some assessment and mitigation possibilities.

Content

Basics in physical glaciology

Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges

Ice falls, ice avalanches

Glacier floods

Lake ice and bearing capacity

Lecture notes

Handouts are available.

Literature

Relevante Literatur wird während der Vorlesung angegeben.

Prerequisites / notice

Für aktuelle Fallbeispiele werden risikobasierte Massnahmen bei glaziologischen Naturgefahren diskutiert.

Voraussetzungen: Es werden Grundkenntnisse in Mechanik und Physik vorausgesetzt.

Fluvial Systems

The course presents a view of the processes acting on and shaping the landscape and the fluvial landforms that result. The fluvial system is viewed in terms of the production and transport of sediment on hillslopes, the structure of the river network and channel morphology, fluvial processes in the river, riparian zone and floodplain, and basics of catchments in river management.

Objective

The course has two fundamental aims: (1) it aims to provide environmental engineers with the physical process basis of fluvial system change, using the right language and terminology to describe landforms; and (2) it aims to provide quantitative skills in making simple and more complex predictions of change and the data and models required.
The course consists of three sections: (1) Introduction to fluvial forms and processes and geomorphic concepts of landscape change, including climatic and human activities acting on the system. (2) The processes of sediment production, upland sheet-rill-gully erosion, basin sediment yield, rainfall-triggered landsliding, sediment budgets, and the modelling of the individual processes involved. (3) Processes in the river, floodplain and riparian zone, including river network topology, channel geometry, aquatic habitat, role of riparian vegetation, including basics of fluvial system management. The main focus of the course is hydrological and the scales of interest are field and catchment scales.

### Lecture notes

There is no script.

### Literature

The course materials consist of a series of 13 lecture presentations and notes to each lecture. The lectures were developed from textbooks, professional journals, and ongoing research activities of the instructor. All material is on the course webpage.

### Prerequisites / notice

Prerequisites: Hydrology 1 and Hydrology 2 (or contact instructor).

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0267-01L</td>
<td>Numerical Hydraulics</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Holzner</td>
</tr>
<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Burlando, S. Fatichi</td>
</tr>
</tbody>
</table>

### 101-0267-01L Numerical Hydraulics

- **Abstract**: In the course Numerical Hydraulics the basics of numerical modelling of flows are presented.
- **Objective**: The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.
- **Content**: The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

### Lecture notes

Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

### Literature

All literature used in lecture is presented in the course. Additional literature is presented during the course.

<table>
<thead>
<tr>
<th>Course Code</th>
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</tr>
</thead>
<tbody>
<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Burlando, S. Fatichi</td>
</tr>
</tbody>
</table>

### 102-0237-00L Hydrology II

- **Abstract**: The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.
- **Objective**: Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelling with practical examples.

### Lecture notes

Parts of the script for “Hydrology II” are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

### Literature

Additional literature is presented during the course.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>Instructor(s)</th>
</tr>
</thead>
</table>
Part I (Advanced Environmental Assessments)
- Inventory database developments, transparency, data quality, data completeness, and data exchange formats, uncertainties
- Software tools (MFA, LCA)
- Allocation (multoutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Impact assessment of waterborne chemical emissions, sum parameters, mixture toxicity
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Subjectivity in environmental assessments
- Multicriteria Decision Analysis
- Case Studies

Part II (Implementation of Environmental and other Sustainability Goals):
- Sustainability problems of the current economic system and its measuring units;
- The structure of a management system, and elements to integrate environmental management (ISO 14001) and social management
  (SA8000 as well as ISO 26000), especially into strategy development, planning, controlling and communication;
- Sustainability Opportunities and Innovation
- The concept of ‘Continuous Improvement’
- Life Cycle Coating, Life Cycle Management
- environmental performance measurement of an organisation, including ‘organisational LCA’ (Ecobalance), based on practical examples of
  companies and new concepts
- single score env. assessment methods (Swiss ecopoints)
- stakeholder management and sustainability oriented communication
- an intro into sustainability issues of supply chain management

Students will get small exercises related to course issues.

Lecture notes
Part I: Slides and background reading material will be available on lecture homepage
Part II: Documents will be available on Ilias

Literature
Will be made available.

Prerequisites / notice
This course should only be elected by students of environmental engineering with a with a Module in Ecological Systems Design. All other
students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental and other
Sustainability goals (with or without exercise and lab).

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students who have not yet had classwork in this topic
are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. (2018). Environmental Life Cycle
Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).

102-0357-00L Waste Recycling Technologies
Waste Recycling Technology (WRT) is sub-discipline of Mechanical Process Engineering. WRT is employed in production plants,
processing contaminated soil, construction wastes, scrap metal, recovered paper and the like. While WRT is well established in Central
Europe, it is only just now catching on in emerging markets as well.

Abstract
At the core of this course is the separation of mixtures of solid bulk materials according to physical properties such as color, electrical
conductivity, magnetism and so forth. After having taken this course, the students should have concept not only of the unit operations
employed in WRT but also of how these unit operations are integrated into the flow sheets of production plants.

Objective
Introduction
Waste Recycling; Scope and objectives
Waste recycling technologies in Switzerland
Fundamentals
Properties of particles; Liberation conditions, Particle size and shape, Porosity of bulk materials
Fluid dynamics of particles: Stationary particle beds, Fluidized beds, Free settling particles
Flow sheet basics: Balancing mass flows
Standard processes: batch vs. continuous
Assessment of separation success: Separation function; grade vs. recovery

Separation Process
Separation according to size and shape (Classification): Screening, Flow separation
Separation according to material properties (Concentration): Manual separation, Electrostatic separation, Sensor technology, Froth flotation

Lecture notes
The script consists of the transparencies shown during the lectures. Background material will be provided on the script-server.

Literature
A list of recommended books will be provided.

Prerequisites / notice
We will approach this topic from the perspective not of theory, but of practical application. However, solid fundamentals in physics (in
particular in mechanics) are strongly recommended.

102-0617-00L Basics and Principles of Radar Remote Sensing for Environmental Applications

Abstract
The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging
techniques for the use of environmental parameter estimation.

Objective
The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation.
At the end of the course the student has the understanding of
1. SAR basics and principles,
2. SAR polarimetry.
3. SAR interferometry and
4. environmental parameter estimation from multi-parametric SAR data

Content
The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different
environmental applications. The outline of the course is the following:
1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano
monitoring, forest height inversion, wood biomass estimation etc.)

Lecture notes
Handouts for each topic will be provided
The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of structural reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented.

The course also includes a tutorial using the UQLab software dedicated to real world structural reliability analysis.

Risk Assessment of Chemicals
Projects on chemical assessment with the focus on the analysis and assessment of basic substance data for selected chemical classes; analysis and modelling of technical processes; characterisation of environmental and health risks. Risk assessment on the basis of quality and protection goals. Estimation of model and parameter uncertainty. Precaution and safety measures.

Projects on chemical assessment with the focus on the following aspects:
- Analysis and assessment of basic substance data for selected chemical classes: physical chemical properties, environmental behaviour (distribution, persistence), human and eco-toxicity (biochemical metabolism, effect mechanisms), safety.
- Analysis and modelling of technical processes determining chemical release into the environment, e.g., chemicals applications.
- Characterisation of environmental and health risks on the basis of exposure and effect models, QSARs from environmental chemistry, toxicology and methods of risk analysis.
- Risk assessment on the basis of quality and safety goals. Estimation of the model and data uncertainty.
- Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

Projects teaching; time frame totals ca. 80 hours.

See recommended literature.

Projects on chemical assessment with the focus on chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system, solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid-water interface, applications to lakes, rivers and groundwater.

Understanding of chemical processes in aquatic systems. Quantitative application of chemical equilibria to processes in natural waters. Evaluation of analytical data from aquatic systems.

Introduction to the chemistry of aquatic systems. Regulation of the composition of natural waters by chemical, geochemical and biological processes. Quantitative application of chemical equilibria to processes in natural waters. The following topics are treated: acid-base reactions, carbonate system; solubility of solid phases and weathering; complexation of metals and metal cycling in natural waters; redox reactions; reactions at the interface solid phase-water; applications to lakes, rivers, groundwater.

Beschränkt auf 6 Projektarbeiten pro Semester
The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is on Transdisciplinary Methods and Applications.

### Overview of the key concepts of corporate sustainability and topics related to Water, Energy, Mobility, and Food

#### Corporate Sustainability

At the end of the course, students should:

- Understand the limits and the potential of corporate sustainability for sustainable development.
- Be able to recognize and realize opportunities for corporate sustainability in a business environment.
- Business implications of sustainable development, in particular for the assessment of sustainability performance, strategic change towards sustainability, technological innovations and sustainability, and finance and corporate sustainability.
- Critical thinking skills for corporate sustainability.
- Develop critical thinking skills (argumentation, communication, evaluative judgment) that are useful in the context of corporate sustainability using an innovative writing and peer review method.

#### Content

- Overview of the key concepts of corporate sustainability and topics related to Water, Energy, Mobility, and Food.
- An introduction to multivariate methods such as analysis of variance and multiple linear regression, where a focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

#### Literature

- Handouts are provided by the lecturers.
- Literature recommendations will be distributed during the lecture.

### 701-1543-00L Transdisciplinary Methods and Applications

#### Abstract

The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem-oriented research projects. TD methods are used in research at the science-society interface and when collaborating across scientific disciplines.

Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

#### Objective

At the end of the course, students should:

- Know: Function, purpose and algorithm of a selected number of transdisciplinary methods.
- Understand: Functional application in case studies and other problem-oriented projects.
- Be prepared for: Transdisciplinary Case Study 2017.
- Be able to reflect on: Potential, limits, and necessity of transdisciplinary methods.

#### Content

The lecture is structured as follows:

- Overview of concepts and methods of inter/transdisciplinary integration of knowledge, values and interests (approx. 20%).
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%).
- Practical application of the methods in a broader project setting (approx. 30%).

#### Literature

- Selected scientific articles and book-chapters.

Prerequisites / notice

This course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.

### 701-1541-00L Multivariate Methods

#### Abstract

The course teaches multivariate statistical methods such as linear regression, analysis of variance, cluster analysis, factor analysis and logistic regression.

#### Objective

Upon completion of this course, the student should have acquired:

1. Knowledge on the foundations of several methods of multivariate data analysis, along with the conditions under which their use is appropriate.
2. Skill in the estimation, specification and diagnostics of the various models.
3. Hands-on experience with those methods through the use of appropriate software and actual data sets in the PC lab.

#### Content

The course will begin with an introduction to multivariate methods such as analysis of variance and multiple linear regression, where a metric dependent variable is "explained" by two or more independent variables. Then two methods for structuring complex data, cluster analysis and factor analysis will be covered. In the last part, procedures for the analysis of relationships involving dichotomous or polytomous dependent variables (e.g., the choice of a mode of transportation) will be discussed.

#### Literature

- Will be announced at the beginning of the course.

### 701-1551-00L Sustainability Assessment

#### Abstract

The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

#### Objective

At the end of the course, students should:

- Know: core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

- Understand and reflect on: the challenges of trade-offs between the different goals of sustainable development;
- the respective impacts on individual and societal decision-making.
Content
The course is structured as follows:
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Trade-offs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lectures</th>
<th>Professor</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0589-00L</td>
<td>Technology and Innovation for Development</td>
<td>3</td>
<td>2V</td>
<td>P. Aerni</td>
</tr>
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</table>

Abstract
Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects.

Objective
- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology
- improved understanding of the role of science and technology in the context of human and societal development

Content
Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies. The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

Lecture notes
Reader with issue-specific articles. E-version is partly available under https://www.ethz.ch/content/specialinterest/gess/cis/international-relations/en/teaching/materials/tech.html

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701-0015-00L Seminar on Transdisciplinary Research for Sustainable Development W 2 credits 2S C. E. Pohl, M. Stauffacher

Abstract The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.

Objective The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

Content The seminar covers the following topics: (1) Theories and concepts of inter- and transdisciplinary research (2) The specific challenges of inter- and transdisciplinary research (3) Involving stakeholders (4) Collaborating disciplines (5) Exploration of tools and methods (6) Analysing participants' projects to improve inter- and transdisciplinary elements

Literature Literature will be made available to the participants
### 701-0473-00L Weather Systems

**Abstract**
This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.

**Objective**
The students are able to explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics - to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena - to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features - to explain how mountains influence the atmospheric flow on different scales

**Content**
- Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

**Lecture notes**
Lecture notes and slides

**Literature**
- Atmospheric Science, An Introductory Survey
  - John M. Wallace and Peter V. Hobbs, Academic Press

### 701-0479-00L Environmental Fluid Dynamics

**Abstract**
This course covers the basic physical concepts and mathematical equations used to describe environmental fluid systems on the rotating Earth. Fundamental concepts (e.g. vorticity dynamics and waves) are formally introduced, applied quantitatively and illustrated using examples. Exercises help to deepen knowledge of the material.

**Objective**
Students are able to:
- name the bases, concepts and methods of environmental fluid dynamics.
- understand and discuss the components of the basic physical equations in fluid dynamics.
- apply basic mathematical equations to simple problems of environmental fluid dynamics.

**Content**
- Basic physical terminology and mathematical laws.
- Continuum hypothesis, forces, constitutive laws, state equations and basic principles of thermodynamics, kinematics, laws of mass and momentum on rotating earth.
- Concepts and illustrative flow systems: vorticity dynamics, boundary layers, instability, turbulence - with respect to environmental fluid systems.
- Scale analysis: dimensions variables and dynamical similarity, simplification of the fluid system, e.g. shallow water assumption, geostrophic flow.
- Waves in environmental fluid systems.

**Lecture notes**
In English language

**Literature**
Will be presented in class.
See also: web-site.

### 701-1315-00L Biogeochemistry of Trace Elements

**Abstract**
The course addresses the biogeochemical classification and behavior of trace elements, including key processes driving the cycling of important trace elements in aquatic and terrestrial environments and the coupling of abiotic and biotic transformation processes of trace elements. Examples of the role of trace elements in natural or engineered systems will be presented and discussed in the course.

**Objective**
The students are familiar with the chemical characteristics, the environmental behavior and fate, and the biogeochemical reactivity of different groups of trace elements. They are able to apply their knowledge on the interaction of trace elements with geosphere components and on abiotic and biotic transformation processes of trace elements to discuss and evaluate the behavior and impact of trace elements in aquatic and terrestrial systems.

**Content**
(i) Definition, importance and biogeochemical classification of trace elements. (ii) Key biogeochemical processes controlling the cycling of different trace elements (base metals, redox-sensitive and chalcophile elements, volatile trace elements) in natural and engineered environments. (iii) Abiotic and biotic processes that determine the environmental fate and impact of selected trace elements.

**Lecture notes**
Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

**Prerequisites / notice**
Students are expected to be familiar with the basic concepts of aquatic and soil chemistry covered in the respective classes at the bachelor level (soil mineralogy, soil organic matter, acid-base and redox reactions, complexation and sorption reactions, precipitation/dissolution reactions, thermodynamics, kinetics, carbonate buffer system).

This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

### 701-1681-00L Element Balancing and Soil Functions in Managed Ecosystems

**Abstract**
Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures.

**Objective**
The students learn to critically assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.

**Content**
The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. You assess the sustainability of current land use and analyse management options improving nutrient and metal cycling in agro-ecosystems. The students will have the opportunity to calculate specific scenarios regarding land use management and environmental changes. Special focus we be paid on the soil services such as regulation-, production function and soil as habitat, and the assessment of these functions based on soil mapping data.

**Lecture notes**
Literature and Exercises for a case study

**Literature**
Literature will be provided.

**Prerequisites / notice**
The course consists of lectures and computer exercises. The course take place every 2 weeks à 4 hours. recommended prerequisites for attending this course:
- Bodenschutz und Landnutzung
- Biochemistry of Trace Elements
- Angewandte Bodenökologie

### 701-1682-00L River Engineering

**Abstract**
The lecture addresses the fundamentals to quantitatively describe the flow of water, the transport of sediments and morphological changes like erosion or deposition in watercourses. Further addressed are the design and dimensioning of river engineering works to create and ensure sufficient capacity, channel stability as well as to ensure the ecological functions of the watercourse.

**Lecture notes**
- Fundamentals of hydrodynamics: fluid mechanics, stability, turbulence, sediments, fluvial processes
- River morphology and sediments
- River design and dimensioning
- River rehabilitation and ecological engineering

**Literature**

**Prerequisites / notice**
This course is recommended for students interested in environmental engineering, fluvial processes, and river management.
Some textbooks related to the material covered in the course:

- Hummel, W. (2020). Air pollutants cause negative effects on humans, wildlife and buildings. To control and reduce the impact of air pollutants, their transfer from sources to receptors needs to be known. This transfer includes transport within the atmospheric boundary layer, chemical transformation reactions and phase-transfer processes from air to liquid and solid materials (aerosols, water, ...). The students understand the fundamental principles of atmospheric transport, dispersion and chemistry of pollutants on the local to regional scale and their transfer between air and condensed phases (aerosols, water, solids). This includes the knowledge of important atmospheric reactions, sources and sinks. The obtained understanding enables the students to apply computational tools to predict the transport and transformation of chemicals at the local to regional scale.

- Henne, S. (2020). The students shall be able to describe the interrelation between discharge, sediment transport and channel evolution quantitatively.

- Noiray, N. (2020). The students shall know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration.

- Meyer-Massetti, D. (2020). The students shall be capable to design and dimension river engineering works needed to influence the processes in watercourses.


- Risken, H., Plötz, L. M., Meister, D. W. M. (2010). Probability theory, single and multiple random variables, mappings of random variables. The students shall be able to develop basic stochastic models of such systems.

- Henne, S. (2020). The lecture notes contain a comprehensive list of references for further reading.


- Meyer-Massetti, D. W. M. (2010). Strongly recommended lectures:
  - Hydrology (102-0293-AAL), Hydraulics I (101-0203-01L) and Hydraulic Engineering (101-0206-00L)


- Meyer-Massetti, D. W. M. (2010). This exercise bases on field data, which are partly collected by the students on a river in nature. Besides the collection of fundamentals and field data, the exercise comprehends the calculation of the stage-discharge relationship, of the critical discharges for initiation of bed load transport and bed erosion and of the annual sediment load in a given river reach.

102-0337-00L Landfilling, Contaminated Sites and Radioactive Waste Repositories

Objective
- The students shall describe and discuss the transfer processes of contaminants within landfills and their impact on the environment.

Content
- The lecture notes provide an overview of the principles of environmental protection in waste management and how they are applied in legislation.

Literature
- Lecture notes “River Engineering” (in German, 470 pages, including list of references)

151-0709-00L Stochastic Methods for Engineers and Natural Scientists

Objective
- The students shall be capable to design and dimension river engineering works needed to influence the processes in watercourses.

Content
- The course provides an introduction into stochastic methods that are applicable for example for the description and modeling of turbulent and subsurface flows. Moreover, mathematical techniques are presented that are used to quantify uncertainty in various engineering applications.

Literature
- Some textbooks related to the material covered in the course:

102-0377-00L Air Pollution Modeling and Chemistry

Objective
- The students shall be capable to design and dimension river engineering works needed to influence the processes in watercourses.

Content
- Air pollutants cause negative effects on humans, wildlife and buildings. To control and reduce the impact of air pollutants, their transfer from sources to receptors needs to be known. This transfer includes transport within the atmospheric boundary layer, chemical transformation reactions and phase-transfer processes from air to liquid and solid materials (aerosols, water, ...). The students understand the fundamental principles of atmospheric transport, dispersion and chemistry of pollutants on the local to regional scale and their transfer between air and condensed phases (aerosols, water, solids). This includes the knowledge of important atmospheric reactions, sources and sinks. The obtained understanding enables the students to apply computational tools to predict the transport and transformation of chemicals at the local to regional scale.
Content
- Structure of the Atmosphere
- Thermodynamics of the atmosphere
- Atmospheric stability
- Atmospheric boundary layer and turbulence
- Dispersion in the atmospheric boundary layer
- Numerical models of atmospheric dispersion
- Gas phase reaction kinetics
- Tropospheric chemistry and ozone formation
- Chemistry box models
- Volatile organic pollutants (VOCs) and semi-volatile organic pollutants (SVOCs)
- Distribution of chemicals between different phases
- Kinetics of phase transfer processes
- Computational tools to estimate volatility, distribution and phase transfer rates of organic chemicals

Lecture notes
Continued updates of:
- Slides and handouts
- Home assignments and sample solutions
- R package and code for some of the home assignments
- Free software packages for estimation of properties and fate of organic chemicals
- Key journal articles as discussed during lecture

Literature
Atmospheric chemistry

Environmental organic chemistry and mass transfer
Mackay D., Multimedia environmental models : the fugacity approach; Boca Raton, Fla. : Lewis Publishers; 2001; 2nd ed

Atmospheric dynamics and boundary layer

Atmospheric modelling

Introduction to R

Prerequisites / notice
strongly recommended: 102-0635-01L Luftreinhaltung (Air Pollution Control) or similar

701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology W 3 credits 2G+2U D. Or

Abstract
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Objective
Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media;
- quantify driving forces and resulting fluxes of water, solute, and heat in soils;
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges
Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.
Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.
Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.
Midterm exam
Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.
Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.
Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.
Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Lecture notes
Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)
http://www.supplement.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature
Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

102-0317-03L Advanced Environmental Assessment (Computer Lab) W 1 credit 1U S. Pfister

Title: Different tools and software used for environmental assessments, such as LCA are introduced. The students will have hands-on exercises in the computer rooms and will gain basic knowledge on how to apply the software and other resources in practice

Objective: Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.

Minors Limited to 6 KP Totaly

Number 102-0215-00L
Title Urban Water Management II
Type W
ECTS 3 credits
Hours 2G
Lecturers M. Maurer, P. Staufer
Prerequisites / notice 1 - 2 Exkursionen

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.
Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Lecture notes
Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)
http://www.supplement.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature
Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

102-0317-03L Advanced Environmental Assessment (Computer Lab) W 1 credit 1U S. Pfister

Title: Different tools and software used for environmental assessments, such as LCA are introduced. The students will have hands-on exercises in the computer rooms and will gain basic knowledge on how to apply the software and other resources in practice

Objective: Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.

Minors Limited to 6 KP Totaly

Number 102-0215-00L
Title Urban Water Management II
Type W
ECTS 3 credits
Hours 2G
Lecturers M. Maurer, P. Staufer
Prerequisites / notice 1 - 2 Exkursionen

**Objective**
Consolidation of the basic procedures for design and operation of technical networks in water engineering.

**Content**
Demand Side Management versus Supply Side Management
Optimierung von Wasserverteilnetzen
Druckstösse
Kalkausschlag, Korrosion von Leitungen
Hygiene in Verteilsystemen
Siedlungshydrologie: Niederschlag, Ablussbildung
Instationäre Strömungen in Kanalisationen
Stofftransport in der Kanalisation
Einleitbedingungen bei Regenwetter
Versickerung von Regenwasser
Generelle Entwässerungsplanung (GEP)

**Lecture notes**
Written material and copies of the overheads will be available.

**Prerequisites / notice**
Prerequisite: Introduction to Urban Water Management

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**101-1249-00L Hydraulics of Engineering Structures**

*W* 3 credits  2G  H. Fuchs, I. Albayrak, L. Schmocker

*Former Title until HS15: Wastewater Hydraulics.*

**Abstract**
Hydraulic fundamentals are applied to hydraulic structures for wastewater, flood protection and hydropower. Typical case studies from engineering practice are further described.

**Objective**
Understanding and quantification of fundamental hydraulic processes with particular focus on hydraulic structures for wastewater, flood protection and hydropower

**Content**
1. Introduction & Basic equations
2. Losses in flow & Maximum discharge
3. Uniform flow & Critical flow
4. Hydraulic jump & Stillling basins
5. Backwater curves
6. Weirs/End overfalls & Venturi
7. Mobile discharge measurements & Culverts/restrictors/inverted siphons
8. Fall manholes & Vortex drop
9. Conjunctions & Shock waves at abrupt wall deflections
10. Air/water flows and bottom outlets
11. Driftwood retention racks
12. Vegetated flows - Introduction
13. Vegetated flows - Application
14. Summary & questions/preparations for examination

**Lecture notes**
Text books

**Literature**

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**101-0339-00L Environmental Geotechnics**

*W* 3 credits  2G  L. M. Plötze

**Abstract**
Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risque management, remediation and reclamation techniques as well as monitoring systems.

Introduction in landfill design and engineering with focus on barrier- and drainage systems and lining materials, evaluation of geotechnical problems, e.g. stability

**Objective**
Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risque management, remediation and reclamation techniques as well as monitoring systems.

Introduction in landfill design and engineering with focus on barrier- and drainage systems as wellas lining materials, evaluation of geotechnical problems, e.g. stability

**Content**
Definition of contaminated sites, site investigation methods, historical research and technical investigation, risque assessment, contamination transport, remediation, clean-up and retaining techniques (e.g. bioremediation, incineration, retaining walls, pump-and-treat, permeable reactive barriers), monitoring, research projects and results

**Lecture notes**
Dr. R. Hermanns Stengele, Dr. M. Plötze: Environmental Geotechnics (german) digital

**Literature**
Exhaustive references are contained in the suggested text book.

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**701-0501-00L Pedosphere**

*W* 3 credits  2V  R. Kretzschmar

**Abstract**
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

**Objective**
Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

**Content**
Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

**Lecture notes**
Lecture notes can be purchased during the first lecture (15.- SFr)

**Literature**

**Prerequisites / notice**
Prerequisites: Basic knowledge in chemistry, biology and geology.

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**701-0533-00L Soil Chemistry**

*W* 3 credits  2G  R. Kretzschmar, D. I. Christl

**Abstract**
This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.

Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, mobility) of nutrients and pollutants.
Content
Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.

Lecture notes
Handouts in lectures.

Literature

★★ Project Work

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0199-01L</td>
<td>Project on Water Resources Management</td>
<td>W</td>
<td>12 credits</td>
<td>24A</td>
<td>Lecturers</td>
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<td></td>
<td>Abstract</td>
<td>W</td>
<td>working during one semester on a task on Water Resources Management</td>
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<tr>
<td></td>
<td>Objective</td>
<td></td>
<td>promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.</td>
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<td></td>
<td>Content</td>
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<td>The project work is supervised by a professor. Students can choose from different subjects and tasks.</td>
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<tr>
<td>102-0299-01L</td>
<td>Project on Urban Water Management</td>
<td>W</td>
<td>12 credits</td>
<td>24A</td>
<td>Lecturers</td>
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<tr>
<td>102-0399-01L</td>
<td>Project on Ecological Systems Design, Air Quality</td>
<td>W</td>
<td>12 credits</td>
<td>24A</td>
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<td>Abstract</td>
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<td>working during one semester on a task on Material Flow and Waste Management</td>
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<tr>
<td>102-0499-01L</td>
<td>Project on Soil Protection</td>
<td>W</td>
<td>12 credits</td>
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<td></td>
<td>Abstract</td>
<td>W</td>
<td>working during one semester on a task on Soil Protection</td>
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<tr>
<td>102-0599-01L</td>
<td>Project on Hydraulic Engineering</td>
<td>W</td>
<td>12 credits</td>
<td>24A</td>
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<td>Abstract</td>
<td>W</td>
<td>working on a concrete task in Hydraulic Engineering</td>
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<td>Objective</td>
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<td>promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.</td>
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★★ Practical Work Experience

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<th>Lecturers</th>
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<tr>
<td>102-0003-00L</td>
<td>External Professional Training</td>
<td>O</td>
<td>16 credits</td>
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<td>Lecturers</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>external professional training according to a special regulation. The compulsory professional training lasts for at least 12 weeks and is a precondition to be allowed to write up the Master thesis, and to acquire the Master degree.</td>
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<td>Objective</td>
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<td>experience how environmentally friendly solutions are reached in praxis.</td>
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<td>Prerequisites / notice</td>
<td></td>
<td>Das Reglement für das obligatorische Berufspraktikum im Masterstudiengang Umweltingenieurwissenschaften kann heruntergeladen werden unter: <a href="http://www.umwelting.ethz.ch/download/Praktregl_MSc_Umwelting.pdf">http://www.umwelting.ethz.ch/download/Praktregl_MSc_Umwelting.pdf</a></td>
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</tbody>
</table>

★★ Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

★★★★ Electives ETH Zürich

Course Catalogue of ETH Zurich

★★★★ Master’s Thesis

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
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<td>102-0010-00L</td>
<td>Master’s Thesis in Water Resources Management</td>
<td>W</td>
<td>24 credits</td>
<td>47D</td>
<td>Supervisors</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>only students who fulfill the following criteria are allowed to begin with their master thesis: a. successful completion of the bachelor programme; b. fulfilling of any additional requirements necessary to gain admission to the master programme.</td>
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<tr>
<td></td>
<td>Objective</td>
<td></td>
<td>the master programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.</td>
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<tr>
<td></td>
<td>Content</td>
<td></td>
<td>the topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.</td>
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<tr>
<td>102-0010-10L</td>
<td>Master’s Thesis in Urban Water Management</td>
<td>W</td>
<td>24 credits</td>
<td>47D</td>
<td>Supervisors</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td>only students who fulfill the following criteria are allowed to begin with their master thesis: a. successful completion of the bachelor programme; b. fulfilling of any additional requirements necessary to gain admission to the master programme.</td>
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<td>Objective</td>
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<td></td>
<td>Content</td>
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<td>to work independently and to produce a scientifically structured work.</td>
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</tbody>
</table>
The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

**102-0010-20L**

**Master's Thesis in Ecological Systems Design, Air Quality Control and Waste Management**

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

**Abstract**

The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

**Objective**

To work independently and to produce a scientifically structured work.

**Content**

The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

**102-0010-30L**

**Master's Thesis in Ecological Systems Design, Air**

The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

**Supervisors**

M. Maurer

**102-0010-40L**

**Master's Thesis in Soil Protection**

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

**Abstract**

The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

**Objective**

To work independently and to produce a scientifically structured work.

**Content**

The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

**GESS Science in Perspective**

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Recommended GESS Science in Perspective (Type B) for D-BAUG.

**Course Units for Additional Admission Requirements**

The courses below are only available for MSc students with additional admission requirements.

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
101-0203-AAL | **Hydraulics I** | E- | 5 credits | 11R | M. Holzner

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

**Abstract**

The course teaches the basics of hydromechanics, relevant for civil and environmental engineers.

**Objective**

Familiarization with the basics of hydromechanics of steady state flows

**Content**

Properties of water, hydrostatics, continuity, Euler equation of motion, Navier Stokes equation, similarity, Bernoulli principle, momentum equation for finite volumes, potential flows, ideal fluids-real fluids, boundary layer, pipe flow, open channel flow, flow in porous media, flow measurements, demonstration experiments in the lecture hall and in the laboratory

**Lecture notes**

Script and collection of problems available

**Literature**

Bollrich, Technische Hydromechanik 1, Verlag Bauwesen, Berlin

---

102-0214-AAL | **Introduction to Urban Water Management** | E- | 6 credits | 4R | E. Morgenroth, M. Maurer

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

**Abstract**

Introduction to urban water management (water supply, urban drainage, wastewater treatment, sewage sludge treatment). Introduction to Urban Water Management is a self-study course.

**Objective**

This course provides an introduction and an overview over the topics of urban water management (water supply, urban drainage, wastewater treatment, sewage sludge treatment). It supports the understanding of the interactions of the relevant technical and natural systems. Simple design models are introduced.
102-0324-AAL  Ecological Systems Analysis  E-  6 credits  4R  S. Helweg

Abstract
Methodological basics and application of various environmental assessment tools.

Objective
Students learn about environmental assessment tools, such as material flow analysis, risk assessment, and life cycle assessment. They can identify and apply the appropriate tool in a given situation. Also, they are able to critically assess existing studies.

Content
- Methodological basics of material flow analysis, risk assessment and life cycle assessment
- Application of these methods to case studies

Literature
Available on the website of the professorships of urban water management. Additional information can be asked during the office hours of the professors’ assistants.

Prerequisites / notice
Some students joining the MSc program in Environmental Engineering at ETH Zürich have to take additional courses from our BSc program. The decision of what courses to take is done at the time of admission at ETH.

This course is required for further in depth courses in urban water management.

Prerequisite: Hydraulics I and Hydrology

102-0325-AAL  Waste Management  E-  4 credits  3R  C. Leitzinger

Abstract
Introduction into the problems of waste handling with the goal to get the ability of seeing and improving the influence of commodities and products with there packaging to the environment - as they are becoming waste. Knowing the different mechanical and chemical processes, which are applicable in the field of waste management.

Objective
- To reconstruct the historical development of the waste problems (C2)
- To know the problems of a modern waste management (C4)
- To see and to improve the influence of commodities and products to the environment (C5)
- To recognize waste and his components as raw material and resources and to get the know how for a correct handling (C6)
- To know the different mechanical and chemical processes, which are applicable in the field of waste management (C6)

Content
- Waste composition as a mirror of the human evolution
- Waste definition (formation, amount, energy content, waste composition)
- Several recycling possibilities and processes
- Thermal waste treatment (electricity/district heat as products), including off-gas cleaning and incineration residue handling with regards to the final residue storage in a landfill and the problems which have to be solved there
- Special fields like biological waste handling (composting, fermentation), handling of special wastes and municipal sewage sludge treatment
- Economical aspects

Literature
see bibliographie in the script

Prerequisites / notice
basic of chemical processes has to be known

102-0455-AAL  Groundwater I  E-  3 credits  2R  M. Willmann, J. Jimenez-Martinez

Abstract
Overview over the field of urban water management.
Introduction into systems analysis.
Characterization of water and water quality.
Requirement of drinking water, production of wastewater and pollutants
Production and supply of drinking water.
Urban drainage, treatment of combined sewer overflow.
Wastewater treatment, nutrient elimination, sludge handling.
Planning of urban water infrastructure.

Objective
- To reconstruct the historical development of the waste problems (C2)
- To know the problems of a modern waste management (C4)
- To see and to improve the influence of commodities and products to the environment (C5)
- To recognize waste and his components as raw material and resources and to get the know how for a correct handling (C6)
- To know the different mechanical and chemical processes, which are applicable in the field of waste management (C6)

Content
- Waste composition as a mirror of the human evolution
- Waste definition (formation, amount, energy content, waste composition)
- Several recycling possibilities and processes
- Thermal waste treatment (electricity/district heat as products), including off-gas cleaning and incineration residue handling with regards to the final residue storage in a landfill and the problems which have to be solved there
- Special fields like biological waste handling (composting, fermentation), handling of special wastes and municipal sewage sludge treatment
- Economical aspects

Literature
See englische Ausgabe

Prerequisites / notice
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.
Abstract

The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.

Objective

a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.

b) Students are able to formulate simple practical flow and transport problems.

c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.

d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.

Content

Introduction, aquifers, groundwater use, sustainability, porosity.

Properties of porous media.

Exercises: Groundwater use, porosity, grain size analysis.

Flow properties, Darcy's law, filter.

Flow equations, stream function.

Exercises: Darcy's law.

Analytical solutions, confined aquifers, steady-state flow.

Exercises: Head isolines.

Use of superposition principles, transient flow, free surface flow.

Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems I.

Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems II.

Exercises: Finite difference formulations to flow problems.

Transport processes.

Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems I.

Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems II.

Exercises: Analytical solutions to transport problems.

Path lines, groundwater protection.

Exercises: Analytical solutions to transport problems.

Groundwater remediation, groundwater management.

Exercises: Groundwater remediation.

Lecture notes

Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index

Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index

Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index

Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

Literature


W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995

Krusemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970

G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

102-0635-AAL Air Pollution Control E- 6 credits 4R J. Wang, B. Buchmann

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract

The lecture provides an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and the impact on air quality. Theoretical description and modeling of these processes, air quality measurement techniques and pollution control techniques are covered.

Objective

The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost.

Content

- the physical and chemical processes leading to emission of pollutants
- air quality analysis
- the meteorological parameters influencing air pollution dispersion
- deterministic and stochastic models, describing the air pollution dispersion
- measurement concepts to observe ambient air pollution
- removal of gaseous pollutants by absorption and adsorption
- control of NOx and SOx
- fundamentals of particulate control
- design and application of wet scrubbers

Literature


Prerequisites / notice

College lectures on basic physics, chemistry and mathematics.
### 102-0474-AAL  Introduction to Water Resources Management  E-  6 credits  4R  P. Burlando

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Abstract**
The course offers an introduction to the basics of water resources analysis and management covering the topics of water demand vs availability, water exploitation and reservoir design, aquatic physics, water quality and pollution, water conservation and remediation in rivers, lakes and aquifers, sustainable water use.

**Objective**
Introduction to the basics of water resources management based on physical and chemical processes; principle of sustainability

**Content**
- Wassergüte: Anforderungen, Schadstoffausbreitung, Selbstreinigung, Thermische Belastung, relevante Schadstoffe und Quellen, Stossbelastungen, Zeitkonstanten und Grössenordnungen.
- Wasserkosten: Struktur von Dargebot und Nachfrage.
- Optionen zur Schliessung der Disparität: Reservoire, Grundwasserspeicher, Überleitungen, Wasserwirtschaftliche Rahmenplanung (Masterplan), Gewässerschutz, Sanierung und Renaturierung (Oberflächengewässer und Grundwasser), Variabilität, Stochastik und Risiko.
- Nachhaltigkeit: Definitionen, Beispiele für nicht-nachhaltiges Wirtschaften, Wasserprobleme der Entwicklungsländer, Wasser und Landwirtschaft, Projektbewertung und Umweltverträglichkeitsprüfung. Ökonomische und Soziologische Bezüge.

Alle Aspekte sollen mit Fallbeispielen illustriert werden.


**Lecture notes**
Skript in wöchentlichen Folgen.

### 252-0846-AAL  Computer Science II  E-  4 credits  9R  F. O. Friedrich

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Abstract**
Introduction to programming in Java. Procedural foundations of programming and outlook to object oriented programming. Variables, types, assignments, control structures (branch, loop), data structures, algorithms, line graphics, graphical user interface. Writing small programs. Working with a professional programming environment (Eclipse).

**Objective**
The students will be able to write simple programs and to modify existing programs.

**Content**
This course offers an introduction to variables, control structures (branch, loop), algorithms and data structures, as well as an outlook to modularisation and object oriented techniques.

In the exercises students train programming skills (in the programming language JAVA). Students can solve the exercises on their own laptop or in the computer labs at ETH. The software used in this course runs on MS Windows, MacOS X and Linux.

**Prerequisites / notice**
Prerequisites: 252-0845-00 Computer Science I (D-BAUG)

### 529-2001-AAL  Chemistry I and II  E-  9 credits  19R  H. Grützmacher, W. Uhlig

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Abstract**
General Chemistry I and II: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium, kinetics, acids and bases, electrochemistry

**Objective**
Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

**Content**
1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)
7. Electrochemistry

**Lecture notes**
Nivaldo J. Tro
Chemistry - A molecular Approach (Pearson), Chapter 1-18

**Literature**
Housecroft and Constable, CHEMISTRY
Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY

### 529-2002-AAL  Chemistry II  E-  5 credits  11R  H. Grützmacher, W. Uhlig

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Abstract**
Chemistry II: Redox reactions, chemistry of the elements, introduction to organic chemistry

**Objective**
Erweiter der allgemeinen Grundlagen und Erarbeiten einer Basis, um Prozesse in komplexeren Umweltsystemen (Wasser / Luft / Boden) in ihrem zeitlichen und quantitativen Ablauf verstehen und beurteilen zu können.
1. Redoxreactions

Rules for nomenclature of inorganic compounds. Systematic description of the groups of elements in the periodical system and the most important compounds of these elements. Formation of compounds as a consequence of the electronoc structure of the elements.

3. Introduction to organic chemistry

Description of the most important classes of compounds and of the functional groups. Principal reactivity of these functional groups. Stereochemistry.

Reaction mechanisms: SN1- and SN2-reactions, electrophilic aromatic substitutions, eliminations (E1 and E2), addition reactions (C=C and C=O double bonds), Chemistry of carbonyl and carboxyl groups.

Rules for nomenclature of inorganic compounds. Systematic description of the groups of elements in the periodical system and the most important compounds of these elements. Formation of compounds as a consequence of the electronoc structure of the elements.

Lecture notes

Literature

701-0255-AAL Biochemistry Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction to basic biochemistry and the most important metabolic reactions.

Objective
Based on the biology and chemistry courses in the 1. and 2. semester more detailed biochemical knowledge about enzymology, membrane biochemistry, and central metabolism will be presented

Content
Program
Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
Structure and function of proteins
Carbohydrates, structure of DNA
Lipids an biological membranes
Enzymes and enzyme kinetics
Catalytic strategies
Metabolism: Basic concepts and design. Repetition of basic thermodynamics
Glycolysis
The citric acid cycle
Oxidative phosphorylation
Fatty acid metabolism

Lecture notes
by Laurence A. Moran (Author), Robert A Horton (Author), Gray Scrimgeour (Author), Marc Perry (Author)

Literature
by Laurence A. Moran (Author), Robert A Horton (Author), Gray Scrimgeour (Author), Marc Perry (Author)

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.

Objective
Teaching of basic knowledge in microbiology.

Content

Literature
Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms

Prerequisites / notice
Basic knowledge in biology and chemistry is a precondition.

102-0293-AAL Hydrology Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract

Objective
Kenntnis der Grundzüge der Hydrologie. Kennenlernen von Methoden, zur Abschätzung hydrologischer Grössen, die zur Dimensionierung von Wasserbauwerken und für die Nutzung von Wasserressourcen relevant sind.
Der hydrologische Kreislauf: globale Wasserressourcen, Wasserbilanz, räumliche und zeitliche Dimension der hydrologischen Prozesse.


Interzeption: Messung und Schätzung.

Evaporation und Evapotranspiration: Prozesse, Messung und Schätzung, potentielle und effektive Evapotranspiration, Energiebilanzmethode, empirische Methode.

Infiltration: Messung, Horton-Gleichung, empirische und konzeptionelle Methoden, F-index und Prozentuale Methode, SCS-CN Methode.

Einzugsgebietsscharakteristik: Morphologie des Einzugsgebiets, topografische und unterirdische Wasserscheide, hypsometrische Kurve, Gefälle, Dichte des Entwässerungssystems.


Schnee und Eis: Schneeeigenschaften und -messungen Schätzung des Schneeschmelzprozesses durch die Energiebilanzmethode, Abluss aus Schneeschmelze, Temperatur-Index- und Grad-Tag-Verfahren.


Lecture notes

Die Kopie der Folien zur Vorlesung können auf den Webseiten der Professur für Hydrologie und Wasserwirtschaft herunterladen werden

Literatur


Prerequisites / notice


Environmental Engineering Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<td>Z</td>
<td>Courses outside the curriculum</td>
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<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>diploma thesis</td>
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<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Educational Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
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<td></td>
<td>This lecture is only apt for students who intend to enrol in the programs &quot;Teaching Diploma&quot; or &quot;Teaching Certificate&quot;. It is about learning in childhood and adolescence.</td>
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<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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<td>Thematische Schwerpunkte:</td>
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<td>Lernen als Verhaltensänderung und als Informationsverarbeitung:</td>
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<td>Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzentwicklung unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien, Geschlechtsunterschiede beim Lernen</td>
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<tr>
<td>851-0240-03L</td>
<td>Introduction to Test Theory and Test Construction in Educational Contexts (University of Zürich)</td>
<td>W</td>
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<td>2S</td>
<td>University lecturers</td>
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<td>Enrolment only possible with Teaching Diploma or DC matriculation.</td>
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<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 200a968</td>
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<td>Mind the enrolment deadlines at UZH:</td>
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<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<td>Abstract</td>
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<td>In this seminar, students establish the scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.</td>
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<td>At the end of the seminar, participants will be in a position to</td>
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<td>- describe the scientific fundamentals of test theory and test structure.</td>
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<td>- evaluate examples of scientifically-developed tests in their application context.</td>
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<td>- if necessary, critically question the performance assessment that they employ in practice and professionalise it still further.</td>
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<td></td>
<td>Content</td>
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<td></td>
<td>Die konkreten Inhalte des Seminars ergeben sich aufgrund der Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:</td>
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<td></td>
<td>- Testentwicklung;</td>
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<td></td>
<td>- Gütekriterien von Tests;</td>
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<td></td>
<td>- Aufgabenkonstruktion;</td>
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<td></td>
<td>- Datenauswertung;</td>
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<td></td>
<td>- Rasch-Modell;</td>
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<td>- Internationale Vergleichstests;</td>
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<td></td>
<td>- Zulassungstests</td>
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<td></td>
<td>Lecture notes</td>
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<td></td>
<td>Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören auch die Handouts der verschiedenen, studentischen Vorträge.</td>
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<tr>
<td></td>
<td>Literature</td>
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<tr>
<td></td>
<td>Als Grundlagenliteratur werden folgende Werke empfohlen:</td>
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<tr>
<td></td>
<td>- Weitere Literatur wird in der Lehrveranstaltung genannt.</td>
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<tr>
<td></td>
<td>Prerequisites / notice</td>
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<td></td>
<td>Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen:</td>
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<td></td>
<td>- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)</td>
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<tr>
<td></td>
<td>- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung</td>
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<td></td>
<td>- Referat (RE)</td>
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<td></td>
<td>- Schreiben einer schriftlichen Arbeit</td>
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<td></td>
<td>Weiter Angaben zu den Leistungsanforderungen werden im Rahmen der Startveranstaltung abgegeben und erläutert.</td>
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<tr>
<td>851-0240-15L</td>
<td>Colloquium on the Science of Learning and Instruction</td>
<td>W</td>
<td>1</td>
<td>1K</td>
<td>E. Stern, P. Greutmann, further lecturers</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td></td>
<td>In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH).</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.</td>
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<tr>
<td>851-0242-05L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching</td>
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</tbody>
</table>
This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”. Number of participants limited to 30. This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”. The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”. The successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

- They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
- They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0823-00L</td>
<td>Environmental Education Didactics I</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>C. Colberg, F. Keller</td>
</tr>
<tr>
<td>701-0827-00L</td>
<td>Teaching Internship Including Examination Lessons</td>
<td>O</td>
<td>6 credits</td>
<td>13P</td>
<td>C. Colberg, F. Keller</td>
</tr>
</tbody>
</table>

- Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated.

Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.
**Objective**

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

**Content**

The students will be able to watch and evaluate the teaching of colleagues and experts. They get profit out of their teaching experiences not only when preparing but also when teaching. Doing so they will be supported by their mentors.

Two lessons of the course will be split off for the examination - procedure.

**Lecture notes**

Dokumente unter
https://www.ethz.ch/de/studium/didaktische-ausbildung/studienangebot-zulassung/didaktik-zertifikat/dokumente--didaktik-zertifikat-.html

- Raster zum Bericht über das Unterrichtspraktikum im DZ Umweltlehre an der ETH Zürich (PDF)
- Beurteilungsbogen Prüfungslektionen Umweltlehre
- Schriftliche Unterrichtsvorbereitung für Prüfungslektionen (PDF)

**Literature**

Wird von der Praktikumslehrperson bestimmt.

---

### Environmental Studies TC - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
In the first semester the students compile what is known about the problem, its causes and possible solutions. Each group of students

C. E. Pohl
Mathematics I
Chemistry I
ECTS
Type
Each year in the case study we analyse a different problem from the field of sustainable development and develop solutions to it.

4G
O,
J. E. E. Buschmann,
This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through

1. Single-Variable Calculus:
- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).
- Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)
- Brown, LeMay, Hursten CHemie (deutsch)
- Housecroft and Constable, CHEMISTRY (englisch)
- Cannas da Silva

2. Linear Algebra and Complex Numbers:
- D. Dutta: Linear Algebra with applications (Pearson Prentice Hall).
- Brown, LeMay, Hursten CHemie (deutsch)
- Housecroft and Constable, CHEMISTRY (englisch)
- Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

3. Ordinary Differential Equations:
- Separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of
- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).

Each year in the case study we analyse a different problem from the field of sustainable development and develop solutions to it. Students are able:

- Developing solutions (design thinking, Checklands' soft systems methodology).
- Qualitative system modelling (Systaim).
- Developing solutions (design thinking, Checklands' soft systems methodology).

Most of the time students work independently in groups. Tutors support the students in key steps. Introductions are given for:

- Inquiry, scientific writing and managing references (by experts of ETH library).
- Role behaviour and collaboration in groups.
- Preparing reports, posters and presentations.
- Qualitative system modelling (Systaim).

During synthesis week, which takes place during semester break, the results of the different part inquiries are integrated in a qualitative

system model. The students identify specific problems within the system and develop solutions.

During synthesis week, which takes place during semester break, the results of the different part inquiries are integrated in a qualitative

system model. The students identify specific problems within the system and develop solutions.

In the first semester the students compile what is known about the problem, its causes and possible solutions. Each group of students

makes an inquiry to a given part of the overall problem. The inquiry includes a thematic as well as stakeholder analysis.

The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the
most important tool for modelling and are therefore a main focus of both of these courses.

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The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the
most important tool for modelling and are therefore a main focus of both of these courses.
Students will compile the case study dossier. Literature on methods will be provided during the case study course.

**551-0001-00L**

**Abstract**
Organismic biology to teach the basic principles of classical and molecular genetics, evolutionary biology and phylogeny. First in a series of two lectures given over two semesters for students of agricultural and food sciences, as well as of environmental sciences.

**Objective**
The understanding of some basic principles of biology (inheritance, evolution and phylogeny) and an overview of the diversity of life.

**Content**
The first semester focuses on the organismal biology aspects of genetics, evolution and diversity of life in the Campbell chapters 12-34.

Week 1-7 by Alex Widmer, Chapters 12-25
12 Cell biology Mitosis
13 Genetics Sexual life cycles and meiosis
14 Genetics Mendelian genetics
15 Genetics Linkage and chromosomes
20 Genetics Evolution of genomes
21 Evolution How evolution works
22 Evolution Phylogenetic reconstructions
23 Evolution Microevolution
24 Evolution Species and speciation
25 Evolution Macroevolution

Week 8-14 by Oliver Martin, Chapters 26-34
26 Diversity of Life Introduction to viruses
27 Diversity of Life Prokaryotes
28 Diversity of Life Origin & evolution of eukaryotes
29 Diversity of Life Nonvascular&seedless vascular plants
30 Diversity of Life Seed plants
31 Diversity of Life Introduction to fungi
32 Diversity of Life Overview of animal diversity
33 Diversity of Life Introduction to invertebrates
34 Diversity of Life Origin & evolution of vertebrates

**Lecture notes**
no script

**Literature**

**Prerequisites / notice**
The lecture is the first in a series of two lectures given over two semesters for students with biology as a basic subject.

**701-0243-01L**

**Biology III: Essentials of Ecology**

**Abstract**
This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in ecological research. Ecological concepts are exemplified by using aquatic and terrestrial systems. Corresponding methodological approaches are demonstrated. In a more applied part of the lecture threats to biodiversity and the appropriate management are discussed.

**Objective**
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the individual, the population, the community and the ecosystem level.

**Content**
- Übersicht der aquatischen und terrestrischen Lebensräume mit ihren Bewohnern
- Einfluss von Umweltfaktoren (Temperatur, Strahlung, Wasser, Nährstoffe etc.) auf Organismen; Anpassung an bestimmte Umweltbedingungen
- Populationsdynamik: Ursachen, Beschreibung, Vorhersage und Regulation
- Interaktionen zwischen Arten (Konkurrenz, Koexistenz, Prädation, Parasitismus, Nahrungsnetze)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Ökosysteme: Kompartimente, Stoff- und Energieflusse
- Biodiversität: Variation, Ursachen, Gefährdung und Erhaltung
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution

**Lecture notes**
Unterlagen, Vorlesungsfolien und relevante Literatur sind in der Lehrdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagmorgen zur Verfügung.

**Literature**
- Bohle 1995. Limnische Systeme. Springer, ca. Fr. 50.-

**701-0027-00L**

**Environmental Systems I**

**Abstract**
The lecture provides a science-based exploration of environmental aspects from three research fields: earth, climate, and health sciences.

**Objective**
The students are able to explain important properties of the three environmental systems, to discuss critical drivers, trends and conflicts of their use, and to compare potential solutions.

**Content**
The lecture discusses the role of the environmental systems based on selected environmental problems, among these the exploration of raw materials and fossil fuels, climate change and its impacts on man and environment, and the spread and control of infectious diseases in the human population and agricultural systems.

**Lecture notes**
Slides are provided by instructors and are accessible via moodle.

**701-0029-00L**

**Environmental Systems II**

**Abstract**
The lecture provides a science-based exploration of three important environmental systems: Inland waters, forest, and of food systems.

**Objective**
The students are able to explain important functions of the three environmental systems, to discuss critical drivers, trends and conflicts of their use and to compare potential solutions.
Content

Aquatic ecosystems and their function, water use and its impact, water pollution and water treatment, coping with floods and water scarcity.

Forests and agroforest systems, trends and drivers of land use changes, sustainable forest management.

The main functions, trends and challenges of agricultural and food systems are discussed based on the four dimensions of food security (availability, access, utilization of food and stability of the food systems).

Lecture notes

Lecture notes or other documentation are provided by instructors and accessible via moodle.

Additional First Year Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0839-00L</td>
<td>Informatics</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>L. E. Fässler, M. Dahinden</td>
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<tr>
<td>Abstract</td>
<td>Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: modeling and simulations, visualization of multidimensional data, managing data with lists and tables and with relational databases, introduction to programming, universal methods for algorithm design.</td>
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<tr>
<td>Objective</td>
<td>The students learn to:</td>
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<tr>
<td></td>
<td>- choose and apply appropriate tools from computer science,</td>
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<td></td>
<td>- process and analyze real-world data from their subject of study,</td>
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<td>- handle the complexity of real-world data,</td>
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<td></td>
<td>- know universal methods for algorithm design.</td>
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<tr>
<td>Content</td>
<td>1. Modeling and simulations</td>
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<td>2. Visualizing multidimensional data</td>
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<td>3. Data management with lists and tables</td>
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<td>4. Data management with a relational database</td>
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<td>5. Introduction to macro programming</td>
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<td></td>
<td>6. Introduction to programming with Python</td>
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<tr>
<td>Literature</td>
<td>All materials for the lecture are available at <a href="http://www.evim.ethz.ch">www.evim.ethz.ch</a></td>
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<tr>
<td>Prerequisites / notice</td>
<td>This course covers the bases for understanding micro- and macroeconomic issues and theories. Participants are given the tools to argue in economic and political terms and to evaluate the corresponding measures. Group and individual exercises deepen the knowledge gained.</td>
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Laboratory Course: Elementary Chemical Techniques

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<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0030-00L</td>
<td>Laboratory Course: Elementary Chemical Techniques</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>N. Kober, M. Morbidelli, M. H. Schroth, B. Wehrli</td>
</tr>
<tr>
<td>Abstract</td>
<td>This practical course provides an introduction to elementary laboratory techniques. The experiments cover a wide range of techniques, including analytical and synthetic techniques (e.g., investigation of soil and water samples or the preparation of simple compounds). Furthermore, the handling of gaseous substances is practised.</td>
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<tr>
<td>Objective</td>
<td>This course is intended to provide an overview of experimental chemical methods.</td>
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<tr>
<td>Content</td>
<td>The classification and analysis of natural and artificial compounds is a key subject of this course. It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks:</td>
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<td>Selected samples (e.g., soil and water) will be analysed with various methods, such as titrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvation or precipitation processes) is studied.</td>
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<td>The synthesis of simple inorganic complexes or organic molecules is practised. Furthermore, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.</td>
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<tr>
<td>Lecture notes</td>
<td>The script will be published on the web. Details will be provided on the first day of the semester.</td>
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<tr>
<td>Literature</td>
<td>A thorough study of all script materials is requested before the course starts.</td>
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</table>

Biology I: Laboratory Exercises

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-0801-00L</td>
<td>Biology I: Laboratory Exercises</td>
<td>O</td>
<td>1</td>
<td>2U</td>
<td>E. B. Truernit</td>
</tr>
<tr>
<td>Objective</td>
<td>Capability of preparing biological specimen, microscopy and documentation. Understanding the correlation between plant structure and function at the level of organs, tissues and cells.</td>
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<tr>
<td>Content</td>
<td>Awareness of the link between plant anatomy, systemsatics, physiology, ecology, and development.</td>
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<td></td>
<td>Measuring object sizes with the microscope. Preparation of specimen for light microscopy. Plant tissue staining techniques.</td>
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<td></td>
<td>Special features of plant cells: Plastids, vacuole, cell wall. Anatomy of seed plants: From cells to organs. Anatomy and function of various plant tissues (epidermis, vascular tissue, wood, etc.). Anatomy and function of different plant organs (root, stem, leaf, flower, fruit, seed).</td>
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<tr>
<td></td>
<td>Anatomical adaptations to different environments.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts For further reading (not obligatory): Gerhard Wanner; Mikroskopisch-Botanisches Praktikum, Georg Thieme Verlag, Stuttgart.</td>
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<tr>
<td>Literature</td>
<td>For further reading (not obligatory): Gerhard Wanner; Mikroskopisch-Botanisches Praktikum, Georg Thieme Verlag, Stuttgart.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Groups of a maximum of 30 students.</td>
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</table>

Social Sciences and Humanities

Principles of Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0757-00L</td>
<td>Principles of Economics</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>R. Schubert</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course covers the bases for understanding micro- and macroeconomic issues and theories. Participants are given the tools to argue in economic and political terms and to evaluate the corresponding measures. Group and individual exercises deepen the knowledge gained.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Students are able to:</td>
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<tr>
<td></td>
<td>- describe fundamental micro- and macroeconomic issues and theories.</td>
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<td></td>
<td>- apply suitable economic arguments to a given theme.</td>
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<td></td>
<td>- evaluate economic measures.</td>
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<tr>
<td>Content</td>
<td>Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomics policies</td>
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<tr>
<td>Lecture notes</td>
<td>available on electronic platform</td>
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</tbody>
</table>
**Bachelor Studies (Programme Regulations 2011)**

**Basic Courses II**

**Examination Blocks**

**Examination Block 1**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0245-00L</td>
<td>Introduction to Evolutionary Biology</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>G. Velicer, S. Wielgoss</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.</td>
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<tr>
<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Topics likely to be covered include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.</td>
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<tr>
<td></td>
<td>Literature</td>
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<tr>
<td></td>
<td>Textbook: Evolutionary Analysis</td>
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<td>Prerequisites / notice</td>
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<td></td>
<td>The exam is based on lecture and textbook.</td>
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</tbody>
</table>

| 701-0255-00L | Biochemistry                  | O    | 2 credits | 2V     | H.P. Kohler |
|              | Abstract                      |      |           |        |             |
|              | Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes. |
|              | Objective                     |      |           |        |             |
|              | Students are able to understand |      |           |        |             |
|              | - the structure and function of biological macromolecules | | | | |
|              | - the kinetic bases of enzyme reactions | | | | |
|              | - thermodynamic and mechanistic basics of relevant metabolic processes | | | | |
|              | Students are able to describe the relevant metabolic reactions in detail | | | | |
Introductory topics in microbiology: cell structure and function, molecular genetics, microbial growth, metabolic diversity, phylogeny and taxonomy, prokaryotic diversity, human-microbe interactions.

**Objective:**
- Teaching of basic knowledge in microbiology
- Wird von den jeweiligen Dozenten ausgegeben.

**Content:**
- Basic concepts and design. Repetition of basic thermodynamics
- Glycolysis, fermentation
- The citric acid cycle
- Oxidative phosphorylation
- Fatty acid metabolism

**Literature:**
- N. Gruber
- E. M. Fischer, T. Peter
- J. Vorholt-Zambelli
- Horton et al. (Pearson) serves as lecture notes.

### Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0023-00L</td>
<td>Atmosphere</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>H. Wernli, E. M. Fischer, T. Peter</td>
</tr>
<tr>
<td></td>
<td>Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.</td>
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<td></td>
<td>Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between weather - climate - atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.</td>
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<tr>
<td></td>
<td>Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.</td>
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<td></td>
<td>Written information will be supplied.</td>
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<tr>
<td>701-0071-00L</td>
<td>Mathematics III: Systems Analysis</td>
<td>O</td>
<td>4</td>
<td>2+1U</td>
<td>N. Gruber, D. Byrne</td>
</tr>
<tr>
<td></td>
<td>The objective of the systems analysis course is to deepen and illustrate the mathematical concepts on the basis of a series of very concrete examples. Topics covered include: linear box models with one or several variables, non-linear box models with one or several variables, time-discrete models, and continuous models in time and space.</td>
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<td>Understanding and applying the systems-analytic approach, i.e., Recognizing the core of the problem - simplification - quantitative approach - prediction.</td>
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<td></td>
<td><a href="http://www.up.ethz.ch/education/systems-analysis.html">http://www.up.ethz.ch/education/systems-analysis.html</a></td>
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<td>Overhead slides will be made available through Ilias.</td>
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<tr>
<td>701-0401-00L</td>
<td>Hydrosphere</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>R. Kipfer, C. Roques</td>
</tr>
<tr>
<td></td>
<td>Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.</td>
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<td></td>
<td>Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.</td>
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<td></td>
<td>Topics of the course.</td>
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<td>Physical properties of water (i.e. density and equation of state)</td>
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<td></td>
<td>- global water resources</td>
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<td></td>
<td>- energy (thermal &amp; kinetic), gas exchange</td>
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<td>- vertical stratification, large scale transport</td>
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<td>- turbulence and mixing</td>
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<td></td>
<td>- mixing and exchange processes in rivers</td>
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<td></td>
<td>- groundwater and its dynamics</td>
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<td></td>
<td>- ground water as part of the terrestrial water cycle</td>
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<td></td>
<td>- ground water hydraulics, Darcy's law</td>
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<tr>
<td></td>
<td>- aquifers and their properties</td>
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<td></td>
<td>- hydrochemistry and tracer</td>
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<tr>
<td></td>
<td>- ground water use</td>
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<tr>
<td></td>
<td>Case studies</td>
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<td></td>
<td>- 1. Water as resource, 2. Water and climate</td>
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<td>In addition to the suggested literature handouts are distributed.</td>
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<tr>
<td></td>
<td>Suggested literature.</td>
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</tbody>
</table>

**Program**

- 752-4001-00L: Microbiology
- 701-0071-00L: Mathematics III: Systems Analysis
- 701-0401-00L: Hydrosphere
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Objective

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Content

Definition of the pedosphere, soils functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

Lecture notes

Lecture notes can be purchased during the first lecture (15.- SFr).


Prerequisites

Prerequisites: Basic knowledge in chemistry, biology and geology.

Laboratory Course in Physics for Students of Environmental Sciences

The course provides an individual experience of physical phenomena and the basic principles of experiments. By carrying out simple physical experiments the students learn the proper use measuring instruments, the correct evaluation of report of the measured data and how to interpret the final results.

Objective

This laboratory course aims to provide basic knowledge of:
- the setup of a physics experiment,
- the use of measurement instruments,
- various measuring techniques,
- the analysis or measurement errors,
- and the interpretations of the measured quantities.

Content

The students select 8 out of 20 experiments which they like to conduct. For each of these experiments the students will analyze the data they measure estimate the error of there measurements and compare these with the physical theory. Additionally each student will present one of their experiments in a seminar.

Lecture notes

Manuals for the experiments are provided online.

Integrated Practical Observation Networks

Observation networks - the combination of individual instruments - are the starting point of quantitative environmental studies. The structure and idiosyncrasies of existing observation networks are shown. When working in individual experiments on practical problems, various types of observation networks are dealt with; questions related to data quality and data availability are discussed.

Objective

Getting acquainted with existing networks. Insight into problems related to measuring and interpreting multi-dimensional fields of atmospheric physical, atmospheric chemical, and geophysical parameters.

Content

Observation networks for atmospheric physical, atmospheric chemical, geophysical, hydrological and climatological parameters on different scales (synoptic: 1000 km; mesoscale: 100 km, and microscale: 100 m). Combination of surface observation with remotely sensed data (satellite, radar). Solving interpolation problems in multi-dimensional fields of the observed variables. Assessing the representativity of local values, i.e., the directly observed variable in an observation network.

Lecture notes

The script is published anew every year. Apart from the description of the scientific problems to be worked on in individual experiments, it contains some theoretical chapters on observation networks, as well as guidelines for writing and publishing scientific papers. The script can be downloaded as pdf from the course webpage.

Literature

Literature is listed in the script.

Corporate Sustainability

The lectures addresses the assessment of corporate sustainability and its links to strategy, technology, and finance. Students learn why sustainability matters for managers and how businesses can act towards it. E-modules allow students to train critical thinking skills. In the 2nd half of the semester, sustainability challenges on water, energy, mobility, and food are explored in group projects.

Objective

Understand the limits and the potential of corporate sustainability for sustainable development

Develop critical thinking skills (argumentation, communication, evaluative judgment) that are useful in the context of corporate sustainability using an innovative writing and peer review method.

Content

Overview of the key concepts of corporate sustainability and topics related to Water, Energy, Mobility, and Food

Business implications of sustainable development, in particular for the assessment of sustainability performance, strategic change towards sustainability, technological innovations and sustainability, and finance and corporate sustainability.

Critical thinking skills for corporate sustainability.

In-depth case studies of corporate sustainability challenges in the track phase: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze technological innovations for sustainability? How to invest money in a sustainable way?

Lecture notes

Presentation slides will be made available on moodle prior to lectures.

Literature

Literature recommendations will be distributed during the lecture.

Ressourcen- und Umweltökonomie

The case studies and the analysis of the questions and problems are integral part of the course.
### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0763-00L</td>
<td>Basic Concepts of Management</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>R. Schwarzenbach</td>
</tr>
</tbody>
</table>

**Abstract**

This course deals with fundamental and proven management concepts. The lecturers emphasize the practical applicability of concepts. The course was designed in close cooperation with practitioners; e.g. Mr. S. Baldenweg, mechanical engineer ETH, MBA Insead, share his experience in several guest lectures.

**Objective**

- Students will be familiar with basic general management concepts.
- Learn about the strategic positioning of small departments within larger organisations.
- Will learn about the fundamental mechanisms for handling change, and will be able to recognise these situations.
- Will learn the basic principles of project management and of successful self-management.
- Will reflect on customer oriented information representation.

**Content**


Die finanzielle Abbildung von Organisationen und Projekten wird übersichtsweise dargestellt und die stufengerechte Darstellung von Informationen anhand von realen Beispielen besprochen.

**Lecture notes**


**Literature**

Discovering Management combines in an innovative format a set of lectures and an advanced business game. The learning model for this course is offered to complement the course 351-0778-00L. The course offers additional exercises and case studies.

Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the importance of factors driving innovation, entrepreneurship, and company success. Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Content
Discovering Management combines in an innovative format a set of lectures and an advanced business game. The learning model for Discovering Management involves "learning by doing." The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking, and corporate social responsibility. The 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow.

This business case is as relevant to someone exploring entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.

Objective
Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich.

No prior knowledge of business or economics is required to successfully complete this course.

**Prerequisites / notice**

Delivered as part of a case study, worked out in groups. Language: Teaching in English on request.
This course covers the basic questions, concepts, theories, methods, and empirical findings of political science.

E. Lieberherr

International Aid and Development

To understand accounting not as an isolated discipline, but as a part of the complex system of the enterprise

Lecturers

ECTS

2G

Course documentation and specified educational books

The lecture is based on the following book to be published in the summer of 2016:

M. Dumondel

Beyond acquiring basic knowledge about policy analysis, this course teaches students how to analytically address current and concrete questions of environmental policy. Through exercises the students learn about political science concepts and frameworks as well as real-life political decision-making processes. The well-grounded examination of complex political conflict situations is an important precondition for the entry into the (environmental policy) workforce or a future research career.

Students are able to critically discuss the various aid instruments of bi-and multilateral donors and NGOs.

Prerequisites:

Basic knowledge of economics

Complementary:


751-1101-00L

Finances and Accounting System

W 2 credits 2G M. Dumondel

Abstract

To understand accounting as a component of the complex system of the enterprise

Objective

To understand accounting not as an isolated discipline, but as a part of the complex system of the enterprise

Content

Accounting as a part of management economics.

The different steps for scheduling and evaluation of the accountancy will be studied. The main part of the lecture is dedicated to the financial accounting nevertheless the fundamentals of the internal cost-accounting will also be presented. The lecture will also include the clarification of concrete cases and the calculation of practical exercises.

Lecture notes

Literature

In the lecture one indicates Course documentation and specified educational books

851-0626-01L

International Aid and Development

W 2 credits 2V I. Günther

Abstract

The course gives economic and empirical foundations for a sound understanding of the instruments, prospects and limitations of international development aid.

Literature

Introduction to the Determinants of Underdevelopment; History of Aid; Aid and Development: Theories and Empirics; Political Economy of Aid; Experience and Impact of Aid; New Instruments of Aid; e.g. Micro-Finance, Budget-Support; Fair-Trade

The processes of change, overuse or destruction of the natural environment through humans have historically placed high demands on


The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It


Students attending this course and passing the required tests (one in the middle, the other at the end of the semester) will obtain 4 ECTS credit points.

701-0747-00L

Environmental Policy of Switzerland I

O 3 credits 2V E. Lieberherr

Abstract

This course presents the basics of policy analysis and the specific characteristics of Swiss environmental policy. Policy instruments, actors and processes are addressed both theoretically as well as by means of current Swiss environmental policy examples.

Objective

Beyond acquiring basic knowledge about policy analysis, this course teaches students how to analytically address current and concrete questions of environmental policy. Through exercises the students learn about political science concepts and frameworks as well as real-life political decision-making processes. The well-grounded examination of complex political conflict situations is an important precondition for the entry into the (environmental policy) workforce or a future research career.

Content

The processes of change, overuse or destruction of the natural environment through humans have historically placed high demands on social and political institutions. In the interplay between the environment, society and economy, the environmental policy field encompasses the sum of public measures that have the goal to eliminate, reduce or avoid environmental degradation. The course systematically presents the basics of environmental policy instruments, actors, programs and processes as well as their change over time. A key aspect is the distinction between politics and political science and specifically environmental policy.

Lecture notes

In the lecture one indicates Course documentation and specified educational books

851-0577-00L

Principles of Political Science

O 4 credits 2V+1U S. Mohrenberg, Q. Nguyen

Abstract

This course covers the basics of political science, concepts, theories, methods, and empirical findings of political science.

Objective

This course covers the basics of political science, concepts, theories, methods, and empirical findings of political science.

Content

This course covers the basics of political science, concepts, theories, methods, and empirical findings of political science.

Literature

This course is based on the following textbook: "Politikwissenschaft: Grundlagen" by Thomas Bernauer, Patrick Kuhn, Stefanie Walter and Detlef Jahn (Nomos, 2015, 3rd Edition).

Prerequisites / notice

Students attending this course and passing the required tests (one in the middle, the other at the end of the semester) will obtain 4 ECTS credit points.

701-0727-00L

Politics of Environmental Problem Solving in Developing Countries

W 2 credits 2G U. Scheidegger

Abstract

The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.
Objective

After completion of the module, students will be able to:
- Identify and appraise ecological aspects in development cooperation, development policies and developing countries’ realities
- Analyze the forces, components and processes, which influence the design, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multinational negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

Content

Key issues and basic concepts related to environmental politics are introduced. Then the course predominantly builds on case studies, providing information on the context, specifying problems and potentials, describing processes, illustrating the change management, discussing experiences and outcomes, successes and failures. The analysis of the cases elucidates factors for success and pitfalls in terms of processes, key elements and intervention strategies.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008

Lecture notes

Information concerning the case studies and specific issues illustrated therein will be provided during the course (uploaded on Moodle)

Literature


Prerequisites / notice

The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the sources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

701-0731-00L Environmental Behavior in Social Context

Abstract

This introductory class in the environmental social sciences covers topics such as environmental behavior, environmental concern, social dilemmas and social norms.

Objective

Overview on current fields of research and their relevance for practical application

Content


Fragen, die uns während des Semesters beschäftigen:
- Wie kommt es zu Umweltschädigungen, obwohl niemand diese beabsichtigt?
- Wer verhält sich besonders umweltbewusst? Wie wirkt dies gemessen?
- Welche Rolle spielt das Umweltbewusstsein?
- Welche Rolle spielen äussere Faktoren (Möglichkeiten, Kosten etc.)?
- Wie sehr lassen wir uns dadurch beeinflussen, was andere machen?
- Koperieren wir nur, wenn auch andere dies tun?

Literature


701-0985-00L Social Intercourse with Current Environmental Risks

Abstract

The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.

Objective

- Getting acquainted to the extended risk concept
- Evaluation of the risks caused by technology within the societal context
- Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology)
- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)
- Knowledge about possibilities for sustainable innovation

Content

- Risks and technical systems (risk categories, risk perception, risk management)
- Illustration with case studies (nanotechnology)
- Implementation (politics, science, media, etc.)
- Decision making (technology assessment, cost/benefit analysis etc.)
- The role of the media
- Prospects for future developments

Literature

The lecture is held biweekly (for 2 hours). The dates are 26.9., 3.10. (out of schedule), 24.10, 7.11, 21.11, 5.12, 19.12

227-0802-02L Sociology

Abstract

Various studies are used to introduce basic sociological concepts, theories and empirical research methods, along with selected sociological topics. The goal of the course is to provide participants with an understanding of working practice in empirical sociology and the central findings of sociological studies.
### Objective Content

To learn about methods of empirical social research and key results of classic and modern sociological studies.


Folgende Themen werden behandelt:

3. Der Beitrag der Sozialtheorie. Vorstellung und Diskussion ausgewählter Studien zu einzelnen Themengebieten, z.B.: (1) Die Entstehung sozialer Kooperation, (2) Reputation und Märkte, (3) Soziale Netzwerke u.a.m.

### Lecture notes

Folien der Vorlesung und weitere Materialien (Fachartikel, Kopien aus Büchern) werden auf der Webseite der Vorlesung zum Download zur Verfügung gestellt.

### Literature

Folien der Vorlesung und weitere Materialien (Fachartikel, Kopien aus Büchern) werden auf der Webseite der Vorlesung zum Download zur Verfügung gestellt.

### Prerequisites / notice

Interesse am Thema und Bereitschaft zum Mitdenken.

### Prerequisites

- A strong background in social sciences and an interest in empirical research.
- Basic knowledge of statistical methods.

### Literature

851-0591-00L **Digital Sustainability in the Knowledge Society**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Weekly Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>W 2 credits</td>
<td>Digital Sustainability in the Knowledge Society</td>
<td>2V M. M. Dapp</td>
<td></td>
</tr>
</tbody>
</table>

**Abstract**

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g., Open Source/Content/Access. The course discusses consequences from different models and introduces "digital sustainability" as an alternative vision for society.

**Objective**

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open/free models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff.

After the lecture, you should (hopefully) be able to:

- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

**Content**

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. „Digitization plus Internet“ allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as „knowledge“ (the fourth factor of production) will become ever more important in the 21st century. Accordingly, „piracy“ and „file-sharing“ are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of „intellectual property“, which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible. Using the PC becomes the new cultural technique of the 21st century. In contrast to „reading, writing and arithmetic“, this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible

**Prerequisites**

- General knowledge of basic concepts in science and technology.
- Familiarity with the principles of intellectual property law.

**Notice**

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

More on teach.digisus.info starting from September. Stay tuned.

### Literature

851-0594-00L **International Environmental Politics**

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<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Weekly Hours</th>
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<tbody>
<tr>
<td>W 3 credits</td>
<td>International Environmental Politics</td>
<td>2V T. Bernauer</td>
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</tr>
</tbody>
</table>

**Abstract**

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

**Objective**

The course presents and explains the general ideas of environmental polices, their history, and their various models. It introduces the role of international organizations in environmental politics and the mechanisms of cooperation. It examines the relationship of environmental politics with other fields of political science, such as security studies and international economics.

**Content**

This course introduces the basic concepts of environmental politics and discusses the role of international organizations in this field. It examines the relationship of environmental politics with other fields of political science, such as security studies and international economics. It also explores the role of environmental politics in the global economy and its impact on international relations.

**Prerequisites**

- A strong background in political science and international relations.
- Familiarity with the principles of environmental science.

**Notice**

This course is designed for students with a strong interest in international relations and environmental politics. It is suitable for students who wish to develop a deeper understanding of the role of international organizations in environmental politics and the relationship of environmental politics with other fields of political science.

More on teach.digisus.info starting from September. Stay tuned.
**Objective**
The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

**Content**
This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory.

**Lecture notes**
Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link ‘Registered students, please click here for course materials’ at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <michaehu@student.ethz.ch>). All assigned papers must be read ahead of the respective meeting. Following the course on the basis of on-line slides and papers alone is not sufficient. Physical presence in the classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GESS library at the IFW building, Haldeneggsteig 4, B-floor, or in the library of D-USYS.

**Literature**
Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link ‘Registered students, please click here for course materials’ at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <michaehu@student.ethz.ch>).

**Prerequisites / notice**
None

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### Module Individual Sciences

#### Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0721-00L</td>
<td>Psychology</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>R. Hansmann, C. Keller, M. Siegrist</td>
</tr>
</tbody>
</table>

**Abstract**
This course provides an introduction to psychological research and modelling, focusing on cognitive psychology and the psychological experiment. Participants learn to formulate problems for psychological investigation and apply basic forms of psychological experiment.

**Objective**
Students are able to
- describe the areas, concepts, theories, methods and findings of psychology.
- differentiate scientific psychology from "everyday" psychology.
- structure the conclusions and significance of an experiment according to a theory of psychology.
- formulate a problem for psychological investigation.
- apply basic forms of psychological experiment.

**Content**
Einführung in die psychologische Forschung und Modellbildung unter besonderer Berücksichtigung der kognitiven Psychologie und des psychologischen Experiments. Themen sind u.a.: Wahrnehmung; Lernen und Entwicklung; Denken und Problemlösen; Kognitive Sozialpsychologie; Risiko und Entscheidung.

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<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>752-2120-00L</td>
<td>Consumer Behaviour I</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>M. Siegrist, C. Keller, B. S. Süüterlin</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior

**Objective**
Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior

### Core Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0771-00L</td>
<td>Environmental Concousness and Public Relations</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>R. Locher</td>
</tr>
</tbody>
</table>

Number of participants limited to 60.

*Sign in until 29.09.2016.*

Please describe your expectations. Why do you want to attend this special topic? Do you have any pre-information about the integral model? Do you have any practical experience in environmental communication?

**Abstract**
"Environmental Concousness and Public Relations" shows how to communicate about environment and sustainability successfully. We look at campaigns, exhibitions and other public relations measures to learn, how to design and realize good communication.

**Objective**
You learn how to handle tools and concepts in environmental communication. And you can evaluate communication projects. We also discuss the evolution of consciousness.

**Content**
- Methods and tools in environmental communication.
- Marketing mix
- Examples of campaigns, events, print products, media relations.
- Integral sustainability

**Lecture notes**
Handouts

**Literature**
- Integral Vision; Ken Wilber, 2005

**Prerequisites / notice**
We will discuss new trends in environmental communication with the focus on integral solutions.

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>701-0785-00L</td>
<td>Environmental and Science Communication</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>M. Schäfer</td>
</tr>
</tbody>
</table>

Number of participants limited to 120. 60 ETH students and 60 UZH students. The time (date and exact time) of enrolment is decisive.

If there are less than 60 enrolments of one group either ETH or UZH students then the available spaces will be given to the other group.

**ATTENTION:** Enrolment of this course unit is only possible from August 31 until September 14, 2016.
The course gives an introductory overview in research questions, theoretical perspectives and empirical results of science communication and environmental communication. They will be illustrated by concrete examples and via lectures from external guests.

Goals: Learning to understand structures and processes of environmental and science communication, becoming more sensitive for problems of science public relations, getting an insight into public debates about environmental issues.

Methods: invitation of media practitioners and experts, discussions, lectures on key theoretical concepts of communication.

Topics: Concrete communication instruments like media conferences, theoretical perspectives of public relations, basic principles and examples of information campaigns, environment and science as media topics, functions and structures of science communication, relations between science, media and politics.

I. Introduction

II. Stakeholders and their Public Relations Efforts

III. Science and Environmental Issues in the Media

IV. Uses and Effects of Science and Environmental Communication

Lecture notes

Literature


Prerequisites / notice

Voraussetzungen: Die Vorlesung hat einführenden Charakter.

Module Humanities

Compulsory Courses

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>701-0701-00L</td>
<td>Philosophy of Science</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>G. Hirsch Hadorn, C. J. Baumberger</td>
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</tbody>
</table>

Abstract

The lecture explores various strands in philosophy of science in a critical way, focusing on the notion of rationality in science, especially with regards to environmental research. It addresses the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

Objective

Students learn to engage with problems in the philosophy of science and to relate them to natural and environmental sciences, thus developing their skills in critical thinking about science and its use. They know the most important positions in philosophy of science and the objections they face. They can identify, structure and discuss issues raised by the use of science in society.

Content

1. Core differences between classical Greek and modern conceptions of science.
2. Classical positions in the philosophy of science in the 20th century: logical empiricism and critical rationalism (Popper); the analysis of scientific concepts and explanations.
3. Objections to logical empiricism and critical rationalism, and further developments: What is the difference between the natural sciences, the social sciences and the arts and humanities? What is progress in science (Kuhn, Fleck, Feyerabend)? Is scientific knowledge relativistic? What is the role of experiments and computer simulations?
4. Issues raised by the use of science in society: The relation between basic and applied research; inter- and transdisciplinarity; ethics and accountability of science.

Lecture notes

A reader will be available for students.
A list of introductory literature and handbooks will be distributed to the students.

Further optional exercises accompany the lecture and offer the opportunity for an in-depth discussion of selected texts from the reader. Students receive an additional credit point. They have to sign up separately for the exercises for the course 701-0701-01 U.

**Environmental Ethics**

**Abstract**

The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

**Objective**

On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and argumentations to be found within the field of environmental ethics and will have practised these in small case studies.

**Content**

- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies. (protection of species, climate change, etc.)

**Lecture notes**

Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.

In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, 2nd Edition Zürich 2014

**Literature**

- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O’Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008

General introductions:

- Marcus Düwell et. al. (Hrg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et. al. (Hrg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

**Prerequisites / notice**

The procedure for accumulating CP will be explained at the start of term.

### Core Courses

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<tr>
<th>Number</th>
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<th>Type</th>
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<tbody>
<tr>
<td>701-0701-01L</td>
<td>Philosophy of Science: Exercises</td>
<td>W</td>
<td>1</td>
<td>1U</td>
<td>G. Hirsch Hador, C. J. Baumberger</td>
</tr>
</tbody>
</table>

**Abstract**

The exercises in philosophy of science serve to develop skills in critical thinking by discussing seminal texts about the rationality of science. Topics discussed include the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

**Objective**

Students can engage with problems in the philosophy of science and to relate them to natural and environmental sciences. They learn to analyze and summarize philosophical texts. In this way, they develop their skills in critical thinking with a focus on the rationality of science.

**Content**

The optional exercises accompany the lecture and serve to develop skills in critical thinking with a focus on the rationality of science, based on discussing seminal texts. The texts cover important positions in the philosophy of science and their critics. Topics discussed include the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

**Lecture notes**

A reader will be available for students.

**Literature**

A list of literature will be distributed to the students together with the reader.

**Prerequisites / notice**

Students that want to subscribe for this course also have to subscribe for the lecture 701-0701-00 V "Wissenschaftsphilosophie". Credit points are given for preparing a structure and a summary of one of the texts.

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<th>Number</th>
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<tbody>
<tr>
<td>701-0791-00L</td>
<td>Environmental History - Introduction and Overview</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>D. Speich Chassé</td>
</tr>
</tbody>
</table>

**Abstract**

Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?

**Objective**

Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems. Improved ability to assess current problems from a historical perspective and to critically interrogate one's own standpoint.

**Lecture notes**

Course material is provided on OLAT.

**Literature**


Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.


**Prerequisites / notice**

Students are asked to write an exam during the second last session (11.12.2015).
### Biomedicine

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<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>227-0399-10L</td>
<td>Physiology and Anatomy for Biomedical Engineers I W</td>
<td>3</td>
<td>2G</td>
<td>551-0317-00L</td>
<td>M. Oxenius, M. Kopf</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance imaging.</td>
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<tr>
<td>Objective</td>
<td>To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.</td>
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<tr>
<td>Content</td>
<td>- The Human Body: nomenclature, orientations, tissues</td>
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<td>- Musculoskeletal system, Muscle contraction</td>
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<td></td>
<td>- Blood vessels, Heart, Circulation</td>
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<td>- Blood, Immune system</td>
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<td>- Respiratory system</td>
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<td></td>
<td>- Acid-Base-Homeostasis</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes and handouts</td>
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<tr>
<td>Literature</td>
<td>Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thieme 2008</td>
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<td></td>
<td>Faller A., Schuenke M. The Human Body; Thieme 2004</td>
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<td></td>
<td>Netter F. Atlas of human anatomy; Elsevier 2014</td>
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#### Immunology I (WS)

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>551-0317-00L</td>
<td>Immunology I W</td>
<td>3</td>
<td>2V</td>
<td>701-0533-00L</td>
<td>M. B. Zimmermann, C. Wolfrum</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.</td>
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<tr>
<td>Objective</td>
<td>Basic knowledge of the mechanisms and the regulation of an immune response.</td>
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<tr>
<td>Content</td>
<td>- Introduction and historical background</td>
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<td></td>
<td>- Intra- and adaptive immunity, Cells and organs of the immune system</td>
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<td></td>
<td>- B cells and antibodies</td>
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<td></td>
<td>- Generation of diversity</td>
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<tr>
<td></td>
<td>- Antigen presentation and Major Histocompatibility (MHC) antigens</td>
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<td></td>
<td>- Thymus and T cell selection</td>
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<td>- Autoimmunity</td>
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<td></td>
<td>- Cytotoxic T cells and NK cells</td>
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<td></td>
<td>- Th1 and Th2 cells, regulatory T cells</td>
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<td>- Allergies</td>
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<td>- Hypersensitivities</td>
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<td></td>
<td>- Vaccines, immune-therapeutical interventions</td>
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<tr>
<td>Lecture notes</td>
<td>Electronic access to the documentation will be provided. The link can be found at &quot;Lernmaterialien&quot;</td>
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<td></td>
<td>Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a &quot;Sessionsprüfung&quot;.</td>
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#### Introduction to Nutritional Science W

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<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>752-6001-00L</td>
<td>Introduction to Nutritional Science W</td>
<td>3</td>
<td>2V</td>
<td>551-0317-00L</td>
<td>M. B. Zimmermann, C. Wolfrum</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course introduces basic concepts of micro- and macronutrient nutrition. Micronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.</td>
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<tr>
<td>Objective</td>
<td>To introduce the students to the both macro- and micronutrients in relation to food and metabolism.</td>
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<tr>
<td>Content</td>
<td>The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.</td>
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<tr>
<td>Lecture notes</td>
<td>There is no script. Powerpoint presentations will be made available.</td>
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### Soil Sciences

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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0533-00L</td>
<td>Soil Chemistry W</td>
<td>3</td>
<td>2G</td>
<td>551-0317-00L</td>
<td>R. Kretzschmar, D. I. Christl</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.</td>
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<tr>
<td>Objective</td>
<td>Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, mobility) of nutrients and pollutants.</td>
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<tr>
<td>Content</td>
<td>Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts in lectures.</td>
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#### Environmental Soil Physics/Vadose Zone Hydrology W

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<th>Number</th>
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<tbody>
<tr>
<td>701-0535-00L</td>
<td>Environmental Soil Physics/Vadose Zone Hydrology W</td>
<td>3</td>
<td>2G+2U</td>
<td>551-0317-00L</td>
<td>D. Or</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/ near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.</td>
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</table>
Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media
Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow - Hydrodynamics:
Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
- Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Lecture notes:
Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)
http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature:
Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

651-3525-00L Introduction to Engineering Geology

W 3 credits 3G S. Löw

Abstract
This introductory course starts from a descriptions of the behavior and phenomena of soils and rocks under near surface loading conditions and their key geotechnical properties. Lab and field methods for the characterization of soils, rocks and rock masses are introduced. Finally practical aspects of ground engineering, including tunneling and landslide hazards are presented.

Objective
Understanding the basic geotechnical and geomechanical properties and processes of rocks and soils. Understanding the interaction of rock and soil masses with technical systems. Understanding the fundamentals of geological hazards.

Content

Lecture notes:
Written course documentation available under "Kursunterlagen".


Methods of Statistical Data Analysis

Number Title Type ECTS Hours Lecturers
701-0105-00L Applied Statistics for Environmental Sciences W 3 credits 2G C. Bigler, U. Brändle, M. Kalisch, L. Meier
### 701-1671-00L Sampling Techniques for Forest Inventories

**Abstract**
Introduction to design and model assisted sampling technique for forest inventory, Two-phase two-stage forest inventories with simple or cluster sampling. Small area estimation. Presentation of the Swiss National Forest Inventory.

**Objective**
Students should have a good understanding of the concepts of general sampling theory in a modern framework. They should also master the specific problems arising in forest inventory and be able, if necessary, to read more specialized books or research papers.

**Content**

**Lecture notes**
Sampling techniques for forest inventories. Daniel Mandallaz, Chapman and Hall. A free electronic copy of the book is also available. A PDF file containing parts of the book will be mailed to the participants.

**Literature**
- Faraway (2005): Linear Models with R
- Draper & Smith (1998): Applied Regression Analysis
- M. Köhl, S. Magnussen, M. Marchetti, 2006, Springer.

**Prerequisites / notice**
A simulation software will be used throughout the lectures to illustrate the theoretical developments. Upon request a half day field demonstration can be organized at the WSL outside the lecture time. A repetitorium for the exam is also offered.

### 401-0625-01L Applied Analysis of Variance and Experimental Design

**Abstract**

**Objective**
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

**Content**

**Literature**

**Lecture notes**
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.

**Prerequisites / notice**
Besuch von "Mathematik IV: Statistik" oder vergleichbare Lehrveranstaltung.

### 401-0649-00L Applied Statistical Regression

**Abstract**
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

**Objective**
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

**Content**
The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

**Lecture notes**
A script will be available.

**Literature**
- Faraway (2005): Linear Models with R
- Faraway (2006): Extending the Linear Model with R
- Draper & Smith (1998): Applied Regression Analysis
- Fox (2008): Applied Regression Analysis and GLMs
- Montgomery et al. (2006): Introduction to Linear Regression Analysis

**Prerequisites / notice**
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

### 401-6215-00L Using R for Data Analysis and Graphics (Part I)

**Abstract**
The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

**Objective**
The students will be able to use the software R for simple data analysis.
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Note: Part I of Using R is complemented and extended by Part II, which is offered during the second part of the semester and which can be taken independently from Part I.

Lecture notes
An Introduction to R. http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf

Prerequisites / notice
The course resources will be provided via the Moodle web learning platform
Please login (with your ETH (or other University) username-password) at
https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145
Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

401-6217-00L Using R for Data Analysis and Graphics (Part II)

Abstract
The course provides the second part an introduction to the statistical software R for scientists. Topics are data generation and selection, graphical functions, important statistical functions, types of objects, models, programming and writing functions.

Objective
The students will be able to use the software R efficiently for data analysis.

Content
Part II of the course builds on part I and covers the following additional topics:
- Elements of the R language: control structures (if, else, loops), lists, overview of R objects, attributes of R objects;
- More on R functions;
- Applying functions to elements of vectors, matrices and lists;
- Object oriented programming with R: classes and methods;
- Tayloring R: options;
- Extending basic R: packages

Lecture notes
The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Prerequisites / notice
Basic knowledge of R equivalent to "Using R .. (part I)" ( = 401-6215-00L ) is a prerequisite for this course.

The course resources will be provided via the Moodle web learning platform
Please login (with your ETH (or other University) username-password) at
https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145
Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

Ecology and Conservation Biology

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<th>Lecturers</th>
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<tr>
<td>701-0305-00L</td>
<td>Vertebrate Ecology</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>W. Suter, J. Senn</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>The course offers an overview on the ecology and conservation biology of birds and mammals. Important concepts from physiology, behavioural ecology, population biology, biogeography and community ecology will be linked to applications in conservation and management. A worldwide perspective will be complemented by a focus on the Central European fauna and its dynamics.</td>
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<td>Objective</td>
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<td>The students are familiar with important topics in animal ecology, with an emphasis on birds and mammals. They are able to link theoretical concepts with visible ecological phenomena, and view them against an evolutionary backdrop. They can thus appraise applied aspects of the conservation and the use of animal populations, such as the influence of larger predators on prey populations or of herbivores on vegetation, the effects of hunting, landscape change, or of other human influences on animal populations. They understand the biogeographical characteristics of the Central European vertebrate fauna and its temporal and spatial dynamics.</td>
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<td>Content</td>
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<td>The course deals with a number of main topics that include feeding and resource use, spatial behaviour and migrations, reproduction, population dynamics, competition and predation, biodiversity and distributions, and dynamics of the Central European fauna. There is an emphasis on linking theory with management issues in conservation and management of wildlife populations. During the first half of the course, examples will be drawn worldwide whereas during the second half, the course will focus more strongly on the European fauna, particularly of the Alpine region. Although the course is not designed to teach natural history of the native species, examples will cover much of the taxonomic breadth of the European fauna. Students are expected to read one paper and to present it to the audience. In addition, two optional field trips will be offered on weekends during the semester (2 days in the Swiss National Park: probably 10-11 October, one day in an important wetland for waterbirds: a Saturday in Nov./Dec., by arrangement). For the detailed program, see the German text.</td>
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<td>Lecture notes</td>
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<td>Lecture notes will be available.</td>
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<td>Literature</td>
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<td></td>
<td>Literature will be listed in the lecture notes, and papers to be presented will be distributed if needed. Some books relevant to the course are (optional reading):</td>
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<td>Prerequisites / notice</td>
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<td>- Everybody will be expected to present a scientific paper in class, to be chosen from a list given.</td>
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701-0405-00L Fresh Water: Concepts and Methods for Sustainable Management

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<th>Lecturers</th>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Literature</td>
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<tr>
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<td>- Everybody will be expected to present a scientific paper in class, to be chosen from a list given.</td>
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</table>
In this course the important freshwater ecosystems, on a global perspective, will be presented. The foci of the lectures are basic ecological properties of those aquatic systems, their anthropogenic influences and subsequent modifications. The learning is organized along case studies, for which conflicting interests, as well as concepts and methods for sustainable management will be discussed.

**Objective**
- basics concerning the functioning of the most important freshwater ecosystems
- basics of the sustainable management of aquatic ecosystems
- application of these principles with case studies
- critical analyses, organization of discussion groups

**Content**
1) Einführung, Gewässerschutzgesetz
2) Biodiversität
3) Sedimenthaushalt
4) Moore - Verbreitung, Schutz und Regeneration
5) Flussrevitalisierung
6) Flussaufweitungen und Blockkramen
7) Auenland und Revitalisation
8) Schutz von Fließgewässern
9) Pumpspeicherwerke
10) Sedimentdynamik
11) Fischwanderung und Kraftwerke
12) Wasser und Gesundheit, Auswirkungen des Klimawandels
13) Schlussdiskussion

**Lecture notes**

**Literature**
Lecturers from the Fallbeispielen werden abgegeben und auf http://www.wsl.ch/info/mitarbeitende/scheideg/vorlesung_binnengewaesser_DE zugänglich gemacht.

**Prerequisites / notice**
Basic ecology lectures of the first four semesters. Students will organize discussion groups.

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**Environmental Chemistry/Ecotoxicology**

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0201-00L</td>
<td>Introduction to Environmental Organic Chemistry</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>M. Sander, K. McNeill</td>
</tr>
</tbody>
</table>

**Abstract**
This course presents significant organic environmental pollutants and the physical-chemical bases required to understand their environmental behavior, and deepens this knowledge through exercises. The most important analytical methods for the qualitative and quantitative determination of organic pollutants in environmental samples are discussed.

**Objective**
- The students are able to
  - name and recognise the most important classes of environmentally-relevant anthropogenic chemicals.
  - explain, on the basis of physical-chemical foundations, the most important processes which determine the environmental behavior of organic pollutants.
  - name fundamental methods of trace analysis of organic pollutants in environmental sampling.
  - propose experimental methods for determining substance-specific properties.
  - identify, on the basis of chemical structure, the processes relevant for the environmental behavior of a compound.
  - critically evaluate published work and data.

**Content**
- Overview of the most important classes of environmental organic pollutants
- Molecular interactions that determine the partitioning behavior (adsorption and absorption processes) of organic compounds between different environmental compartments (gas, liquid, solid)
- Physical-chemical properties (vapor pressure, aqueous solubility, air-water partition constant, organic solvent-water partition constants, etc) and partitioning behavior of organic compounds between environmentally relevant phases (air, aerosols, soil, water, biota)
- Basics of trace analytical methods to determine organic compounds (enrichment techniques, separation (chromatography), detection)
- Chemical transformation reactions of organic pollutants in aquatic and in terrestrial systems (reactions with nucleophiles incl. hydrolysis, elimination, addition)

**Lecture notes**
Script will be distributed

**Literature**


**Prerequisites / notice**
Die Lehrveranstaltung richtet sich nicht nur an jene Studierenden, welche sich später chemisch vertiefen wollen, sondern ausdrücklich auch an alle jene, welche sich mit der Problematik von organischen Schadstoffen in der Umwelt vertraut machen wollen, um dieses Wissen in anderen Vertiefungen anzuwenden.

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**701-1663-00L** Exploring Resilience of Tropical Forest Landscapes

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**701-0225-00L** Organic Chemistry
Objective

The students are able to differentiate between structural and stereoisomers. They know the basics of the biosynthesis of terpenes.

Content

Isomerism (structural isomers, stereoisomers).

Descriptive chemistry of natural products (glycerides, peptides, saccharides).

Reaction mechanisms (substitutions, additions, eliminations, condensations).

The citric acid cycle, the glyoxylate cycle.

Biosynthesis of terpenes.

Literature

Carsten Schmuck, Basisträger Organische Chemie, Pearson

Prerequisites / notice

Der Stoff der Basiscchemie wird vorauszusetzen.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0297-00L</td>
<td>Applied Ecotoxicology</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>K. Fent</td>
</tr>
<tr>
<td>529-0051-00L</td>
<td>Analytical Chemistry I</td>
<td>W</td>
<td>3 credits</td>
<td>3G</td>
<td>D. Günther, M.O. Ebert, R. Zenobi</td>
</tr>
<tr>
<td>701-0479-00L</td>
<td>Environmental Fluid Dynamics</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>H. Wernli, M. Croci-Masspoli</td>
</tr>
<tr>
<td>101-0203-01L</td>
<td>Hydraulics I</td>
<td>W</td>
<td>5 credits</td>
<td>3V+1U</td>
<td>R. Stocker</td>
</tr>
</tbody>
</table>

Objective

The course teaches the basics of hydromechanics, relevant for civil and environmental engineers.

Familiarization with the basics of hydromechanics of steady state flows.

Literature


This lecture focusses on basic concepts of ecotoxicology and their application to enviromental chemicals and environmental pollution problems. Basic concepts are regarded with respect to their consequences for the environment. Toxicological effects on organisms are analysed at different levels of organisation, from the molecular to the ecosystem level. Case studies are regarded in order to understand chemical actions and their effects. In addition bioaccumulation and their consequences, the methods in ecotoxicology and environmental effects of various compounds will be regarded. Emphasis will be placed on hormonally active compounds and their effects to aquatic organisms. Furthermore, methods of environmental risk assessment of environmental pollutants will be discussed.


Prerequisites / notice

Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

Environmental Physics

This course covers the basic physical concepts and mathematical equations used to describe environmental fluid systems on the rotating Earth. Fundamental concepts (e.g. vorticity dynamics and waves) are formally introduced, applied quantitatively and illustrated using examples. Exercises help to deepen knowledge of the material.

Basic physical terminology and mathematical laws:

Continuum hypothesis, forces, constitutive laws, state equations and basic principles of thermodynamics, kinematics, laws of mass and momentum on rotating earth.

Concepts and illustrative flow systems: vorticity dynamics, boundary layers, instability, turbulence - with respect to environmental fluid systems.

Scale analysis: dimensionless variables and dynamical similarity, simplification of the fluid system, e.g. shallow water assumption, geostrophic flow.

Waves in environmental fluid systems.

In English language

Will be presented in class. See also: web-site.

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1481 of 1571
### Content
Properties of water, hydrostatics, stability of floating bodies, continuity, Euler equation of motion, Navier-Stokes equations, similarity, Bernoulli principle, momentum equation for finite volumes, potential flows, ideal fluids vs. real fluids, boundary layer, pipe flow, open channel flow, flow measurements, demonstration experiments in the lecture hall

### Lecture notes
Script and collection of previous problems

### Literature
Bollrich, Technische Hydromechanik 1, Verlag Bauwesen, Berlin

<table>
<thead>
<tr>
<th>102-0455-01L</th>
<th>Groundwater I</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>M. Willmann</th>
</tr>
</thead>
</table>

#### Abstract
The course provides an introduction into quantitativ analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.

#### Objective
a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.

b) Students are able to formulate simple practical flow and transport problems.

c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.

d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.

#### Content
Introduction, aquifers, groundwater use, sustainability, porosity.

Properties of porous media.

Flow properties, Darcy's law, filter.

Flow equations, stream function.

Analytical solutions, confined aquifers, steady-state flow.

Use of superposition principles, transient flow, freee surface flow.

Finite difference solutions to flow problems I.

Finite difference solutions to flow problems II.

Analytical solutions to transport problems I.

Analytical solutions to transport problems II.

Path lines, groundwater protection.

Groundwater remediation, groundwater management.

Transport processes.

Analytical solutions to transport problems I.

Analytical solutions to transport problems II.

Path lines, groundwater protection.

Groundwater remediation.

Lecture notes
Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index
Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index
Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index

Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

#### Literature
W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995
Krusemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970
G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

---

### Module Engineering and Planning

### Spacial and Transport Planning

#### Number
701-0951-00L

#### Title
GIS - Introduction into Geoinformation Science and...

#### Type
W

#### ECTS
5 credits

#### Hours
2V+3P

#### Lecturers
M. A. M. Niederhuber, S. Salvini

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Data: 06.11.2018 12:57

Autumn Semester 2016

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You become acquainted with the regulative, juridical and economic requirements of project development in renewable energies in the field of wind power, solar power and hydro power. Necessary frame conditions for profitable projects

**Number:** 701-0967-00L

**Title:** Project Development in Renewable Energies

**Type:** W

**ECTS:** 2

**Hours:** 2G

**Lecturers:** R. Rechsteiner, A. Appenzeller, A. Wanner

**Abstract:** Project development in renewable Energies

Realization of projects in the field of renewable energies, analysis of legal frame conditions and risks. Necessary frame conditions for profitable projects

**Objective:** You become acquainted with the regulative, juridical and economic requirements of project development in renewable energies in the field of wind power, solar power and hydro power.

You learn to launch and judge projects by exercises in groups.

You recognize chances and risks of renewable energy projects

**Content:**

- Business models for renewable energy projects
- Introduction of market trends, market structure, technical trends and regulation in Switzerland and in the EU internal energy market
- Process development samples and exercises in wind power, hydro power, photovoltaics
- Due diligence and country assessment.

**Lecture notes:**

- PPT presentation will be distributed (in German)
- special frames:
  - http://www.rechsteiner-basel.ch/Lehrmittel.27.0.html

- Exact Program in German below

**Prerequisites / notice:**

- No remarks.

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**Universität der Bundeswehr München**

**Institut für Geoinformationssysteme (IGIS)**

**Autumn Semester 2016**

**ECTS:** 2

**Type:** W

**Number of participants limited to 30.**

**Literature:**


Wiley & Son, Ltd. Chichester.

One Friday is reserved for a field trip or guest speaker;

- Presentation possibilities of spatial data
- Process modelling with vector and raster data
- Digital elevation models and derived products
- Spatial Analysis II: operators and functions with raster data
- Possibilities of data collection
- Transition of reference frame
- Presentation possibilities of spatial data

- Due diligence and country assessment.
- Photovoltaics
- Hydro power
- Wind power

Project development samples and exercises in

Realization of projects in the field of renewable energies, analysis of legal frame conditions and risks.

The students learn basics of renewable energy project realization from acknowledged experts active in the field.

They develop sample projects in practice within groups.

They identify different tasks of various investor types.

The students learn basics of renewable energy project realization from acknowledged experts active in the field.

They develop sample projects in practice within groups.

They identify different tasks of various investor types.

- Due diligence and country assessment.

Exact Program in German below

http://www.rechsteiner-basel.ch/index.php?id=27

http://www.rechsteiner-basel.ch/Lehrmittel.27.0.html

Data: 06.11.2018 12:57

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Autumn Semester 2016
Identification of Woody Plants in Winter

Woody plants are important elements of forest ecosystems and landscapes. The practical characterization of forest stands often requires knowledge of selected native tree and shrub species in winter. Understanding relationships of trees and forest ecosystems by in situ scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Abstract

Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.

Objective

Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content


Lecture notes

Lecture notes will be distributed electronically during the course.

Literature


Prerequisites

For group exercise and presentation reasons the number of participants is limited to 35 students. For exercises students build learning and presentational groups.

529-0193-00L Renewable Energy Technologies I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
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<tr>
<td>701-0317-00L</td>
<td>Identification of Woody Plants in Winter</td>
<td>W</td>
<td>1 credit</td>
<td>1G</td>
<td>A. Rudow</td>
</tr>
</tbody>
</table>

Abstract

Identification of Woody Plants in Winter

Woody plants are important elements of forest ecosystems and landscapes. The practical characterization of forest stands often requires the identification of woody plants in winter. The course focuses on the practical identification of native tree and shrub species to be used for the characterization of forest stands.

Objective

Knowledge of selected native tree and shrub species in winter. Understanding relationships of trees and forest ecosystems by in situ observation of woody plants and forest stands. Introduction into the characterization of forest stands.

Content

Four half-day excursions in the surroundings of Zurich and Baden the identification of native tree and shrub species is treated. The course aims at broadening and application of species knowledge towards the identification of woody plants during the leafless phase and their identification from distance (selected native species). Besides that the relationships of trees and forest ecosystems as well as forestry aspects are elucidated. In the context of an individual work the students will practically train and deepen their acquired knowledge.

Lecture notes


Prerequisites

For group exercise and presentation reasons the number of participants is limited to 35 students. For exercises students build learning and presentational groups.

701-0901-00L ETH Week 2016: Challenging Water

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract

The ETH Week is an innovative one-week course designed to foster critical thinking and creative learning. Students from all departments as well as professors and external experts will work together in interdisciplinary teams. They will develop interventions that could play a role in solving some of our most pressing global challenges. In 2016, ETH Week will focus on the topic of water.

Prerequisites

Half-day excursions into forests. Weatherproof clothes are presupposed. The course is based on the Introduction into Dendrology (spring sem, 2nd sem).
How can a glossary of tools be used as a basis for reading cities and recognizing in them current trends and urban phenomena? The learning material can be downloaded from the student-server: afp://brillembourg-klumpner-server.ethz.ch

**Content**

The week is mainly about problem solving and design thinking applied to the complex world of water. During ETH Week students will have the opportunity to work in small interdisciplinary groups, allowing them to critically analyze both their own approaches and those of other disciplines, and to integrate these into their work.

While deepening their knowledge about how the food system works, students will be introduced to various methods and tools for generating creative ideas and understand how different people are affected by each part of the system. In addition to lectures and literature, students will acquire knowledge via excursions into the real world, empirical observations, and conversations with researchers and experts.

A key attribute of the ETH Week is that students are expected to find their own problem, rather than just solve the problem that has been handed to them. Therefore, the first three days of the week will concentrate on identifying a problem the individual teams will work on, while the last two days are focused on generating solutions and communicating the team’s ideas.

A panel of experts will judge your presentations at the end of the week. The winning teams will receive attractive prizes.

**Prerequisites / notice**

No prerequisites. Program is open to Bachelor and Masters from all ETH Departments. All students must apply through a competitive application process that will open in March 2016 at www.ethz.ch/ETHWeek. Participation is subject to successful selection through this competitive process.

**Objective**

- Domain specific knowledge: Students have immersed knowledge about a certain complex, societal topic which will be selected every year. They understand the complex system context of the current topic, by comprehending its scientific, technical, political, social, ecological and economic perspectives. The focus in 2016 is on challenging water systems.
- Analytical skills: The ETH Week participants are able to structure complex problems systematically using selected methods. They are able to acquire further knowledge and to critically analyze the knowledge in interdisciplinary groups and with experts and the help of team tutors.
- Design skills: The students are able to use their knowledge and skills to develop concrete approaches for problem solving and decision making to a selected problem statement, assess, critically reflect these approaches and to present this work in a creative way (role-plays, videos, exhibitions, etc.).
- Self-competence: The students are able to plan their work effectively, efficiently and autonomously. By considering approaches from different disciplines, they are able to make a judgment and form a personal opinion. In exchange with non-academic partners from business, politics, administration, nongovernmental organizations and media they are able to communicate appropriately, present their results professionally and creatively and convince a critical audience.
- Social competence: The students are able to work in multidisciplinary teams, i.e. they can reflect critically their own discipline, debate with students from other disciplines and experts in a critical-constructive and respectful way and can relate their own positions to different intellectual approaches. They can assess how far they are able to actively make a contribution to society by using their personal and professional talents and skills and as “Change Agents”.

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Abstract

The aim of these lecture is to present the processes controlling the uptake and transport of nutrients and water by the plant, the assimilation of nutrients in the plant, the effect of nutrients on crop yield and quality, the role of the soil as a source of nutrients for crops, and the basic principles of fertilization of different crop types using mineral and organic fertilizers.

Objective

At the end of the lecture, students know how mineral nutrients and water are taken up through roots and circulate in the plants and what their roles in plants are. They understand the importance of nutrients for yield formation and for crop product quality. They are able to propose fertilization plans adapted for field crops growing under Swiss conditions.

Content

A general introduction explains the needs of appropriately managing nutrients in plant production. Afterwards, we will study the physiology of plant nutrition (nutrient uptake by roots; water and nutrient transports in the plant; physiological roles of nutrients in the plant). Then the role of nutrients for yield formation and their effects on crop quality is dealt with. Finally, the bases of crop fertilization are taught (availability of nutrient in soil; N, P and K fertilization; different types of fertilizers).

Lecture notes

We will distribute a script for the part dealing with the physiology of plant nutrition. For the part on fertilization we will use the booklet of ACW and ART presenting the recommendations for the fertilization of crops and grassland in Switzerland (GRUDAF/DBF).

Literature


751-4801-00L System-Oriented Management of Herbivore Insects I

The students gain a good understanding of fundamental aspects of pest management in agroecosystems. They will have the ability to assess options for action in view of requirements from the economy, the ecology and the society.

751-4801-00L System-Oriented Management of Herbivore Insects II

The focus is on the potential to assess strategies and tactics of pest management, taking into account the demands from the economy, the environment and the society. Significant agricultural approaches will be explained using practical examples, including prevention using natural resources, surveillance and forecasting, resistance management, as well as product registration, incl. ecotoxicology.

Specialization in an Environmental System

Biogeochemistry

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
701-0216-00L | Biogeochemical Cycles | W | 3 | 2G | B. Wehrli
701-0419-01L | Seminar for Bachelor Students: Biogeochemistry | O | 2 | 2S | G. Furrer, R. Kretzschmar, B. Wehrli
701-0423-00L | Chemistry of Aquatic Systems | W | 3 | 2G | L. Winkel
701-0533-00L | Soil Chemistry | W | 3 | 2G | R. Kretzschmar, D. I. Christl

Courses of the Specialisation in an Environmental System
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils. Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0459-00L</td>
<td>Seminar for Bachelor Students: Atmosphere and Climate</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Knutti, H. Joos, O. Stebler</td>
</tr>
</tbody>
</table>

In this seminar all students in the realm of atmospheric and climate science convene to train presentation techniques (talks, posters) by means of classic and modern scientific articles.

In this seminar all students in the realm of atmospheric and climate science convene to train presentation techniques (talks, posters) by means of classic and modern scientific articles.
This course imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

### Content
- Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linear, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Three obligatory exercises, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary: a Matlab introduction is given). Example programs and graphics tools are supplied.

### Lecture notes
Documents are offered via the course's web page.

### Literature
List of literature is provided.

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### Prerequisites / notice
This course can only be offered to a limited number of students, however, in any case for everybody having to attend it compulsory. We beg you to sign in to this course early.

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### 701-0461-00L

**Numerical Methods in Environmental Sciences**

<table>
<thead>
<tr>
<th>Semester</th>
<th>Credits</th>
<th>Type</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>C. Schär, O. Fuhrer</td>
</tr>
</tbody>
</table>

**Abstract**

This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Objective**

This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Content**

Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linear, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

### Lecture notes
Documents are offered via the course's web page.

### Literature
Documents are offered via the course's web page.

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### Prerequisites / notice
This course can only be offered to a limited number of students, however, in any case for everybody having to attend it compulsory. We beg you to sign in to this course early.

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### 701-0471-00L

**Atmospheric Chemistry**

<table>
<thead>
<tr>
<th>Semester</th>
<th>Credits</th>
<th>Type</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Ammann, D. W. Brunner</td>
</tr>
</tbody>
</table>

**Abstract**

This lecture provides an introduction to atmospheric chemistry at bachelor level. It introduces the kinetics of gas phase and heterogeneous reactions on aerosols and in clouds and explains the chemical and physical mechanisms responsible for global (e.g. stratospheric ozone depletion) as well as regional (e.g. urban air pollution) environmental problems.

**Objective**

The students will understand the basics of gas phase and heterogeneous reactions and will know the most relevant atmospheric chemical processes taking place in the gas phase as well as between different phases including aerosols and clouds.

The students will also acquire a good understanding of atmospheric environmental problems including air pollution, stratospheric ozone destruction and changes in the oxidative capacity of the global atmosphere.

**Content**

- Origin and properties of the atmosphere: structure, large scale dynamics, UV radiation
- Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of bimolecular and termolecular reactions.
- Tropospheric photochemistry: Photolysis reactions, photochemical O3 formation, role and budget of HOx, dry and wet deposition
- Aerosols and clouds: chemical properties, primary and secondary aerosol sources
- Multiphase chemistry: heterogeneous kinetics, solubility and hygroscopicity, NOx chemistry, SO2 oxidation, secondary organic aerosols
- Air quality: role of planetary boundary layer, summer- versus winter-smog, environmental problems, legislation, long-term trends
- Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol
- Global aspects: global budgets of ozone, methane, CO and NOx, air quality - climate interactions

### Lecture notes
Lecture notes and slides

### Literature
Lecture notes and slides

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### Prerequisites / notice
Attendance of the lecture "Atmosphäre" LV 701-0023-00L or equivalent is a pre-requisite.

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### 701-0473-00L

**Weather Systems**

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<th>Credits</th>
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<th>Authors</th>
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<tr>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. A. Sprenger, C. Grams</td>
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</table>

**Abstract**

This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.

**Objective**

The students are able to:

- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena
- to explain the dynamics of the global circulation and of synoptic- and meso-scale flow features
- to explain how mountains influence the atmospheric flow on different scales

**Content**

Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

### Lecture notes
Lecture notes and slides

### Literature
Atmospheric Science, An Introductory Survey

John M. Wallace and Peter V. Hobbs, Academic Press

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### 701-0475-00L

**Atmospheric Physics**

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<td>W</td>
<td>3</td>
<td>2G</td>
<td>U. Lohmann, A. A. Mensah</td>
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</tbody>
</table>

**Abstract**

This course covers the basics of atmospheric physics, which consist of: cloud and precipitation formation, thermodynamics, aerosol physics, radiation, as well as the impact of aerosols and clouds on climate and artificial weather modification.

**Objective**

Students are able to:

- explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.
- to evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.

**Content**

Moist processes/thermodynamics; aerosol physics; cloud formation; precipitation processes, storms; importance of aerosols and clouds for climate and weather modification, clouds and precipitation

### Lecture notes
Powerpoint slides and script will be made available

### Literature

### Prerequisites / notice
50% of the time we use the concept of "flipped classroom" (en.wikipedia.org/wiki/Flipped_classroom), which we introduce at the beginning.

We offer a lab tour, in which we demonstrate with some instruments how some of the processes, that are discussed in the lectures, are measured.

There is an additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but voluntary.

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### Environmental Biology

Data: 06.11.2018 12:57
Autumn Semester 2016
Page 1488 of 1571
This course provides the ecological systems' knowledge needed to question applied sustainability solutions. We will critically assess the
ecosystem structures and processes that are crucial for understanding biodiversity and ecosystem function. This includes an overview of
ecosystem services and their contribution to human well-being. Students will learn how to identify and communicate ecological
solutions that are based on ecosystem resilience and functional biodiversity. The seminar combines elements of a classic lecture,
group discussions and problem-based learning. It is helpful, but not essential to be familiar with the "seven stages" method (see e.g.
course 701-0352-00L "Analysis and Assessment of Environmental Sustainability" by Christian Pohl et al.).

**Prerequisites / notice**
The course combines elements of a classic lecture, group discussions and problem-based learning. It is helpful, but not essential to be
familiar with the "seven stages" method (see e.g. course 701-0352-00L "Analysis and Assessment of Environmental Sustainability" by
Christian Pohl et al.).

**References**


Schulze et al. (2005) Plant Ecology; Springer.


**Lecture notes / literature**
It is not essential to borrow/buy the following books. We will continuously provide excerpts and other literature during the course.


Schulze et al. (2005) Plant Ecology; Springer.

Additional references include:
- Schulze et al. (2005) Plant Ecology; Springer.

**Handouts and further reading**
Handouts and further reading will be available electronically at the beginning of the semester.
Prerequisites
- General knowledge of plant biology
- Basic knowledge of plant systematics
- General ecological concepts

701-1413-00L Population and Quantitative Genetics

Abstract
This course is an introduction to the rapidly developing fields of population and quantitative genetics, emphasizing the major concepts and ideas over mathematical formalism. An overview is given of how mutation, genetic drift, gene flow, mating systems, and selection affect the genetic structure of populations. Evolutionary processes affecting quantitative and Mendelian characters are discussed.

Objective
Students are able to
- describe types and sources of genetic variation.
- describe fundamental concepts and methods of quantitative genetics.
- use basic mathematical formalism to describe major population genetic concepts.
- discuss the main topics and developments in population and quantitative genetics.
- model population genetic processes using specific computer programs.

Content
Population Genetics:
Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory.

Quantitative Genetics:
Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding, effects on fitness; Fisher's fundamental theorem.

Lecture notes
Handouts

Literature

Prerequisites / notice
There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.

701-1413-01L Ecological Genetics

Abstract
This course focuses on fundamental concepts and methods in ecological genetics. Topics covered include genetic diversity, natural selection, adaptation, reproductive isolation, hybridization and speciation.

Objective
Students will be able to
- assess and propose methods to study pertinent questions in ecological genetics
- to combine knowledge from different disciplines, including population and quantitative genetics, ecology and evolution
- to analyse evolutionary processes in natural populations

Content
Concepts and methods for the study of genetic diversity, natural selection, adaptation, reproductive isolation, hybridization and speciation. Handouts will be provided electronically.

Prerequisites / notice
Recommending:
We recommend that you also follow the course 701-1413-00L - Population and Quantitative Genetics either in advance or in parallel.

Human-Environment Systems

Number Title Type ECTS Hours Lecturers
701-0301-00L Applied Systems Ecology W 3 credits 2V D. Schröter, A. Gessler

Abstract
This course provides the ecological systems’ knowledge needed to question applied solutions to current environmental issues. Our central aim is to balance participants’ respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water.

Objective
At the end of the course...
...you know how to structure your inquiry and how to proceed the analysis when faced with a complex environmental issue. You can formulate the relevant questions, find answers (supported by discussions, input from the lecturers and the literature), and you are able to present your conclusions clearly and cautiously.
...you understand the complexity of interactions and structures in ecosystems. You know how ecosystem processes, functions and services interact and feed back across multiple spatio-temporal scales (in general, plus in depth case examples).
...you understand that biodiversity and the interaction between organisms are an integral part of ecosystems. You are aware that the link between biodiversity and process/function/service is rarely fully understood. You know how to honestly deal with this lack of understanding and can nevertheless find, critically analyse and communicate solutions.
...you understand the importance of ecosystem services for society.
...you have an overview of the methods of ecosystem research and have a deeper insight into some of them, e.g. ecosystem observation, manipulation and modelling.
...you have reflected on ecology as a young discipline at the heart of significant applied questions.

Content
This course provides the ecological systems’ knowledge needed to question applied sustainability solutions. We will critically assess the complexity of current environmental issues, illustrating basic ecological concepts and principles. Our central aim is to balance participants’ respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water.

The course is structured around four larger topical areas: (1) Integrated Water Management -- Green infrastructure (land management options) as an alternative to engineered solutions (e.g. large reservoirs) in flood and drought management; (2) Fire dynamics, the water cycle and biodiversity -- The surprising dynamics of species life cycles and populations in arid landscapes; (3) Rewilding, e.g. re-introducing apex predators (e.g. wolves), or large ungulates (e.g. bisons) in protected areas -- A nature conservation trend with counterintuitive effects; (4) Coupling of aquatic and terrestrial systems: carbon, nitrogen and phosphorus transfers of global importance on landscape scale.

Lecture notes
Case descriptions, commented glossary and a list of literature and further resources per case.

Literature
It is not essential to borrow/buy the following books. We will continuously provide excerpts and other literature during the course.


Schulze et al. (2005) Plant Ecology; Springer.

Prerequisites / notice
The course combines elements of a classic lecture, group discussions and problem based learning. It is helpful, but not essential to be familiar with the "seven stages" method (see e.g. course 701-0352-00L “Analysis and Assessment of Environmental Sustainability” by Christian Pohl et al.).
Abstract

Analysis of central mechanisms of the anthroposphere: ecological economics, theory of institutions and innovation, development economics.

Objective

Introduction to the theoretical foundations of the analysis of central mechanisms of the anthroposphere in a sustainable development perspective.

Knowledge of the different scientific and political discussions on sustainable development.

Knowledge of selected analytical tools (Ecological Economics, economic analysis of institutions, innovation theory, Ordnungstheorie, Theory of liberal economic policy).

Ability to identify central non sustainable mechanisms and policies, to formulate adequate research questions, to choose and to use adequate analytical tools, and to elaborate solutions.

Content

Sustainable development-update: origins, conceptions, state of the discussion. What's left after 25 years of discussion?


Market Economy:

Its Critics, Reforms and new Developments.

An Inquiry into the Nature and Causes of ...Non-Sustainability: Selected mechanisms and trends. The neo-mercantilism-syndrom

New Trends in the Growth Debate:

The Growth-spiral (Hans Chr. Binswanger), Prosperity without growth? (T. Jackson), Intelligent Growth (R. Fücks)

The Internet of Things and Collaborative Commons - on the road to “The Zero Marginal Cost Society”?

Sufficiency: Perspectives of a resource-light society

Corporation 2020 - Transforming Business for Tomorrow's World (Remarks on Pavan Sukhdev's bestseller)

Finance Crash and Debt Crisis - new challenges for Democracy & Market Economy

Resourcecource, Resources, democracy and economic development

Globalization: Facts and elements of a fair globalization

It’s the software! Institutional Innovations for Sustainable Development. Let's continue writing The Federalist Papers!

On the way to the second "Great Transformation"

Perspectives for further, deeper analysis

skript and additional texts are distributed in the course

A first selection:

- Ralf Dahrendorf (2003): Auf der Suche nach einer neuen Ordnung, München
- Jared Diamond (2005): Collapse: How Societies Choose to Fall or Succeed, New York
- Ralf Fücks (2013): Intelligent wachsen, Die grüne Revolution, München
- Friedrich A. von Hayek (1972): Theorie komplexer Phänomene, Tübingen
- oekom e.V., Hrsg. (2013): Baustelle Zukunft, die Grosse Trasformation von Wirtschaft und Gesellschaft, oekom Verlag, München
- Karl Polanyi (1944): The Great Transformation

Jeremy Rifkin (2014): The Zero Marginal Cost Society: The Internet of things, the Collaborative Commons, and the Eclipse of Capitalism, palgrave macmillan
- Uwe Schneidewind / Angelika Zahnt (2013): Damit gutes Leben einfacher wird. Perspektiven einer Suffizienzpolitik, München

Further reading and citations are listed in the skript and mentioned in the course.

Prerequisites / notice

Willingness to prepare intensively the topics and to participate actively in the course

701-0659-00L

Tropical Forests, Agroforestry and Complex Socio-Ecological Systems

The course will focus on integrated landscape approaches for the management of tropical forest landscapes, by addressing the complex interactions between ecological processes, stakeholders' strategies and public policies. Dedicated tools such as games and simulation models to improve knowledge and foster collective decision-making processes will be explored.
Objective

Through the course the students will learn:

Section 1: Concepts and Methods
1. To master definitions and concepts: SES; Vulnerability; Resilience, Environmentalist Paradox.
2. To gain exposure to methods for assessing stakeholders perceptions/practices/knowledge.

Section 2: Recognising diversity & Interdisciplinarity
1. To understand points of views/normative views and how these shape management objectives and practices.
3. To explore interdisciplinary approaches to natural resources management.

Section 3: Topics and Arenas
1. To understand links between Forest, Trees and Livelihoods - poverty, food security & well-being.
2. Gain familiarity with drivers of deforestation; degradation; reforestation.
3. Knowledge of global arenas affecting the international forest regime, and their impact at the local level.
4. To recognise and understand trade-offs between conservation and development in a forest/agroforest context;

A major objective of the course is to encourage students to develop a critical analysis of existing conservation and development narratives within the frame of agroforestry and forested agricultural landscapes. The course will also provide students with methods and tools to assess stakeholders perceptions/practices and knowledge, that will be of use in their professional life.

Content

The course will address:

1. Definitions of forests and agroforests, deconstructing the rigid historical divisions between these two, and showing the complexities and implications legal definitions have on the management systems. We will also address the definitions of Social and Ecological Systems (SES), and Resilience, useful for the entire course. We will provide insights on how to describe the SES using the ARDI methodology (Actors, Resources, Dynamics and Interactions)
2. Methodological frameworks to understand drivers and coping strategies of stakeholders (Sustainable livelihood framework & Vulnerability; Ecosystem Services & trade-offs; Companion Modelling and Adaptive Management; Surveys and Participatory Appraisals)

Building upon this, and introducing the Forest Transition curve as guiding framework for the course, a series of case studies will be presented, highlighting the different drivers and issues at each stage of the transition curve (Kanninen et al. 2007).

1. Tropical Forestry - including Reduced Impact Logging, Forest Certification, and International Timber Market.
2. Secondary forests and Agroforests - landscape mosaics, forest fragments, non timber forest products, slash and burn systems, small holder production systems.
3. Conversions and Deforestation: Global trends, Biofuel extensions .
5. Conclusion - Future trends; Global Arenas and Local Governance.

The course will tackle new and emerging topics such as the role of forests and trees in adaptation to climate change, the links between forest, poverty and food security and the need to mainstream conservation of biodiversity outside protected areas. The course will draw from diverse disciplines, from ecology, economy, sociology, political sciences and legal studies as the most preeminent ones.

The course will enlarge the scope of the students from the ecological process to the social and political components of tropical social and ecological systems. It will address topics and case studies that the students will have little opportunity to address elsewhere, linking them to issues of global relevance in environmental sciences.

Literature


701-0791-00L
Environmental History - Introduction and Overview

Objective

1. Definitions of forests and agroforests, deconstructing the rigid historical divisions between these two, and showing the complexities and implications legal definitions have on the management systems. We will also address the definitions of Social and Ecological Systems (SES), and Resilience, useful for the entire course. We will provide insights on how to describe the SES using the ARDI methodology (Actors, Resources, Dynamics and Interactions)
2. Methodological frameworks to understand drivers and coping strategies of stakeholders (Sustainable livelihood framework & Vulnerability; Ecosystem Services & trade-offs; Companion Modelling and Adaptive Management; Surveys and Participatory Appraisals)

Building upon this, and introducing the Forest Transition curve as guiding framework for the course, a series of case studies will be presented, highlighting the different drivers and issues at each stage of the transition curve (Kanninen et al. 2007).

1. Tropical Forestry - including Reduced Impact Logging, Forest Certification, and International Timber Market.
2. Secondary forests and Agroforests - landscape mosaics, forest fragments, non timber forest products, slash and burn systems, small holder production systems.
3. Conversions and Deforestation: Global trends, Biofuel extensions .
5. Conclusion - Future trends; Global Arenas and Local Governance.

The course will tackle new and emerging topics such as the role of forests and trees in adaptation to climate change, the links between forest, poverty and food security and the need to mainstream conservation of biodiversity outside protected areas. The course will draw from diverse disciplines, from ecology, economy, sociology, political sciences and legal studies as the most preeminent ones.

The course will enlarge the scope of the students from the ecological process to the social and political components of tropical social and ecological systems. It will address topics and case studies that the students will have little opportunity to address elsewhere, linking them to issues of global relevance in environmental sciences.

Literature


701-0963-00L
Energy and Mobility

Objective

The main objectives of this lecture are:
1. Students gain profound knowledge on how to frame problems related to the reduction of energy demand (or greenhouse gas emissions) of mobility (sub-)systems.
2. Students have an overview on the most relevant technological potentials (fuel-based and vehicle-based).
3. Students can assess whether a given reduction goal is ambitious or not, and whether given policy tools are adequate to reach the defined reduction goal.

Prerequisites / notice


Students are asked to write an exam during the second last session (11.12.2015).
Content
The lecture Energy and Mobility deals with the intersection of energy and transportation with focus on motorized individual transport. The lecture deals with the question, how the energy demand, or greenhouse gas emissions, of mobility can be reduced. A five step approach provides a common framework:

a) Status quo and Scope: Definition of the system boundary (whole transport system, or only road transport) and of the status quo of that system (energy demand and energy carrier mix for this system, current technology mix, transportation services provided).

b) Trends and Targets: Analysis of trend development of the mobility system under consideration, establishment of a trend scenario (baseline scenario). Definition of the reduction targets (expressed in terms of energy demand or greenhouse gas emissions; base year and target year: absolute or relative reduction target).

c) Potential Analysis: Analysis of currently employed technologies and of upcoming technologies. Identification of the reduction potential of current, conventional technologies and of future, alternative technologies. Technologies cover both the fuel and the vehicle side.

d) Policy Measures: Possible policy measures, direct, indirect and macro-level effects of policies, psychological aspects of decision making, elements of behavioral economics and prospect theory, combination of policies into policy mixes.

e) Effects and Side Effects: Forecasting the effects of policy measures, differentiation between effects that can be quantified and those that cannot. Identification of unintended (side) counter-effects like rebound effects and perverse incentives.

Forest and Landscape

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0553-00L</td>
<td>Landscape Ecology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>F. Kienast, L. Pellissier</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The course is an introduction to Landscape Ecology and Landscape Modelling and provides various practical applications of Landscape Ecology in nature and landscape management. The students are able to explain and apply the concepts and methods of landscape analysis using examples, to explain causes and effects of changes in landscape using examples and simulations, to describe practical applications of Landscape Ecology in the management of nature and landscape.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The students are able:</td>
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<td></td>
<td>- to explain and apply the concepts and methods of landscape analysis using examples,</td>
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<td>- to explain causes and effects of changes in landscape using examples and simulations,</td>
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<td>- to describe practical applications of Landscape Ecology in the management of nature and landscape.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Contents of the lecture:</td>
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<td></td>
<td>- important terms and concepts of Landscape Ecology,</td>
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<td>- analysis of landscape pattern (metrics),</td>
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<td>- landscape modelling,</td>
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<td>- perception of landscapes,</td>
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<td>- landscape inventories used for nature and landscape protection.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>There is no script. Slides and other materials are provided on Moodle.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Master students seeking recognition of this course in the Bologna process have to show adequate knowledge of the landscape ecology topics described above and have to read selected chapters of:</td>
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<td><strong>Prerequisites / notice</strong></td>
<td>This lecture uses the flipped classroom concept. Students acquire major parts of the knowledge self-paced on the Moodle platform. Contact hours (approx. every 2nd week) deepen and complement the content with additional case studies, examples and discussions.</td>
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<td>It is advantageous but not required to have some GIS knowledge for this lecture and the practical ‘Praktikum Wald und Landschaft’ (spring semester) which is loosely linked with this lecture.</td>
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701-0559-00L Seminar for Bachelor Students: Forest and Landscape O

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<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Interdisciplinary seminar on forest and landscapes with particular emphasis on the key processes shaping the development of forest ecosystems and landscapes.</td>
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<td><strong>Objective</strong></td>
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<td>- To analyze scientific original articles and other complex materials critically and to present the results in an understandable way.</td>
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<td>- To understand selected processes, cases and methods related to forest and landscape issues.</td>
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<td>- To be able to analyze problems related to forest ecosystems and landscape from the viewpoint of various disciplines.</td>
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<td><strong>Content</strong></td>
<td>Biological, ecological, physical and technical processes with impacts on the community, ecosystem and landscape scale. Social processes and institutions with relation to land use. Products and services of forest ecosystems and landscapes. Forest management systems. The contributions will be organized around topical clusters.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Literature references will be provided by the lecturers.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Literature references will be provided by the lecturers.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>The credits are given if the following requirements are met</td>
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<tr>
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<td>a) oral presentation (15-20 Min + discussion)</td>
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<td>b) seminar paper (up to approx. 5 pages, with references, no powerpoint printout).</td>
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701-0561-00L Forest Ecology

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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>This course conveys the basics of forest ecology with an emphasis on trees as those organisms that dominate the physiognomy and the dynamics of forest ecosystems. Based on this course, students have a good grasp of the qualitative and quantitative importance of forest ecosystems at the global and regional scales, with a focus on central Europe.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Students are able to:</td>
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<td>- summarize the fundamentals of forest ecology at the autecological, demecological and synecological level</td>
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<td>- explain how trees dominate the physiognomy and dynamics of forest ecosystems</td>
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<tr>
<td></td>
<td>- describe the qualitative and quantitative importance of forest ecosystems at the global and regional scales, with an emphasis on central Europe and Alpine region.</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Introduction and overview of the forests of the world</td>
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<tr>
<td></td>
<td>Forest ecosystem ecology: Production ecology of forests</td>
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<tr>
<td></td>
<td>Autecology: light, temperature, wind, water, and nutrients</td>
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<tr>
<td></td>
<td>Demecology: regeneration ecology, forest growth, mortality</td>
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<tr>
<td></td>
<td>Synecology: Fundamentals of trophic interactions (forest-ungulate interactions), succession</td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Handouts (mixture of overhead slides and full text chapters) are sold at cost</td>
<td></td>
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</tr>
<tr>
<td><strong>Literature</strong></td>
<td>Relevant chapters from textbooks will be indicated.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>The contents of the following courses of the 2nd year of the USYS BSc are required:</td>
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</tbody>
</table>

Knowledge from the following courses of the 2nd year of the USYS BSc are an asset:

701-0312-00L Pflanzen- und Vegetationsökologie
701-0314-00L Systematische Botanik
By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature. Depending on the chosen orientation of the thesis, the students learn these skills through an empirical analysis, a literature review, via design tasks or through an applied project.

A short bachelor's thesis should consist of a text, with graphs and figures, of 15-20 pages.

For Risks to life and human assets, risk management is essential. This course utilizes case studies to teach how a future natural hazards-specialist should analyze, assess and manage risks.

The course includes practical work (microscopy).

**Bachelor's Thesis**

Students can choose between one Bachelor thesis of 10 KP or two Bachelor theses of 5 KP each.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0010-02L</td>
<td>Short Bachelor's Thesis in Social Sciences and Humanities</td>
<td>W</td>
<td>5 credits</td>
<td>11D</td>
<td>Lecturers</td>
</tr>
<tr>
<td>701-0010-03L</td>
<td>Short Bachelor's Thesis in Natural Sciences and Engineering</td>
<td>W</td>
<td>5 credits</td>
<td>11D</td>
<td>Lecturers</td>
</tr>
<tr>
<td>701-0010-10L</td>
<td>Bachelor's Thesis</td>
<td>W</td>
<td>10 credits</td>
<td>21D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

**Abstract**

By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature. Depending on the chosen orientation of the thesis, the students learn these skills through an empirical analysis, a literature review, via design tasks or through an applied project.

By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature. Depending on the chosen orientation of the thesis, the students learn these skills through an empirical analysis, a literature review, via design tasks or through an applied project.

By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature. Depending on the chosen orientation of the thesis, the students learn these skills through an empirical analysis, a literature review, via design tasks or through an applied project.
Objective
By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature.

Content
The BA is written either under the “Social sciences and humanities” or the “Natural sciences and technology” modules. The thesis may also be inter- and transdisciplinary.

A bachelor's thesis in the domain “Social sciences and humanities” usually deals with an issue at the interface of those sciences, the environment and sustainability. Methods of data collection, analysis and interpretation stemming from the social sciences are applied. A bachelor's thesis in "Natural sciences" deals with a topic at the interface of natural sciences, the environment and sustainability. The methods of data collection, analysis and interpretation appropriate to the natural sciences are used. A thesis in "Technology" deals with the environmental effects of use and application. The thesis may take the form of an analysis or review of a current technology, or the design of a future technological application. In an inter- or transdisciplinary thesis, knowledge from various fields and disciplines would be merged on the basis of an overarching question, or developed via the input of key societal actors.

A bachelor's thesis should consist of a text, with graphs and figures, of 30-40 pages.

Environmental Sciences Bachelor - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Environmental Sciences Master

► Major in Atmosphere and Climate

►► Prerequisites

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0471-01L</td>
<td>Atmospheric Chemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Ammann, D. W. Brunner</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture provides an introduction to atmospheric chemistry at bachelor level. It introduces the kinetics of gas phase and heterogeneous reactions on aerosols and in clouds and explains the chemical and physical mechanisms responsible for global (e.g. stratospheric ozone depletion) as well as regional (e.g. urban air pollution) environmental problems.

**Objective**
The students will understand the basics of gas phase and heterogeneous reactions and will know the most relevant atmospheric chemical processes taking place in the gas phase as well as between different phases including aerosols and clouds.

**Content**
- Origin and properties of the atmosphere: structure, large scale dynamics, UV radiation
- Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of bimolecular and termolecular reactions.
- Tropospheric photochemistry: Photolysis reactions, photochemical C_3 formation, role and budget of HOx, dry and wet deposition
- Aerosols and clouds: chemical properties, primary and secondary aerosol sources
- Multiphase chemistry: heterogeneous kinetics, solubility and hygroscopicity, N_2O_5 chemistry, SO2 oxidation, secondary organic aerosols
- Air quality: role of planetary boundary layer, summer- versus winter-smog, environmental problems, legislation, long-term trends
- Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol
- Global aspects: global budgets of ozone, methane, CO and NOx, air quality - climate interactions

**Lecture notes**
Vorlesungsunterlagen (Folien) werden laufend während des Semesters jeweils mind. 2 Tage vor der Vorlesung zur Verfügung gestellt.

**Prerequisites / notice**
List of literature is provided.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0473-00L</td>
<td>Weather Systems</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. A. Sprenger, C. Grams</td>
</tr>
</tbody>
</table>

**Abstract**
This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.

**Objective**
The students are able to
- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena
- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features
- to explain how mountains influence the atmospheric flow on different scales

**Content**
Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

**Lecture notes**
Lecture notes and slides

**Literature**
Atmospheric Science, An Introductory Survey
John M. Wallace and Peter V. Hobbs, Academic Press

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0475-00L</td>
<td>Atmospheric Physics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>U. Lohmann, A. A. Mensah</td>
</tr>
</tbody>
</table>

**Abstract**
This course covers the basics of atmospheric physics, which consist of: cloud and precipitation formation, thermodynamics, aerosol physics, radiation as well as the impact of aerosols and clouds on climate and artificial weather modification.

**Objective**
Students are able to
- to explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.
- to evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.

**Content**
Moist processes/thermodynamics; aerosol physics; cloud formation; precipitation processes, storms; importance of aerosols and clouds for climate and weather modification, cloud and precipitation formation, moisture and condensation processes

**Lecture notes**
Powerpoint slides and script will be made available

**Literature**

**Prerequisites / notice**
50% of the time we use the concept of "flipped classroom" (en.wikipedia.org/wiki/Flipped_classroom), which we introduce at the beginning.

We offer a lab tour, in which we demonstrate with some instruments how some of the processes, that are discussed in the lectures, are measured.

There is an additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but voluntary.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0461-00L</td>
<td>Numerical Methods in Environmental Sciences</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>C. Schär, O. Fuhrer</td>
</tr>
</tbody>
</table>

**Abstract**
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Objective**
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Content**
Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Three obligatory exercises, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary: a Matlab introduction is given). Example programs and graphics tools are supplied.

**Lecture notes**
Is provided (CHF 10.- per copy).

**Literature**
List of literature is provided.

►► Weather Systems and Atmospheric Dynamics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
</tbody>
</table>

**Abstract**
Dynamic, synoptic Meteorology
### Climate Processes and Feedbacks

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1235-00L</td>
<td>Cloud Microphysics</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>U. Lohmann, Z. A. Kanji</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 16.</td>
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<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td></td>
<td>Clouds are a fascinating atmospheric phenomenon central to the hydrological cycle and the Earth’s climate. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes.</td>
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<tr>
<td></td>
<td>Content</td>
<td></td>
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<td></td>
<td>The learning objective of this course is that students understand the formation of clouds and precipitation and can apply learned principles to interpret atmospheric observations of clouds and precipitation.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
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<td></td>
<td>see: <a href="http://www.iac.ethz.ch/edu/courses/master/modules/cloud-microphysics.html">http://www.iac.ethz.ch/edu/courses/master/modules/cloud-microphysics.html</a></td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>Target group: Master students in Atmosphere and Climate</td>
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</tbody>
</table>

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1251-00L</td>
<td>Land-Climate Dynamics</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>S. I. Seneviratne, E. L. Davin</td>
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<td></td>
<td>Number of participants limited to 16.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.</td>
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<tr>
<td></td>
<td>Objective</td>
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<td></td>
<td></td>
<td>The students can understand the role of land processes and associated feedbacks for the climate system.</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<td>Powerpoint slides will be made available</td>
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</table>

### Atmospheric Composition and Cycles

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1233-00L</td>
<td>Stratospheric Chemistry</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>T. Peter, A. Stanke</td>
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<tr>
<td></td>
<td>Number of participants limited to 16.</td>
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<tr>
<td></td>
<td>Objective</td>
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<td>The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
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<td></td>
<td>Short presentation of thermodynamical and kinetic basics of chemical reactions: bi- and terthermo molecular reactions, photo-dissociation. Introduction to the chemical family concept: active species, their source gases and reservoir gases. Detailed treatment of the pure oxygen family (odd oxygen) according to the Chapman chemistry. Radical reactions of the ozone family species with nitric oxide, active halogens (chlorine and bromine) and odd hydrogen. Ozone depletion cycles. Methane depletion and ozone production in the lower stratosphere (photo-smog reactions). Heterogeneous chemistry on the background aerosol and its significance for heavy air traffic. Chemistry and dynamics of the ozone hole: Formation of polar stratospheric clouds and chlorine activation.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
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<td>Documents are provided in the contact hours.</td>
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</tbody>
</table>
Climate History and Palaeoclimatology

This course will introduce some of the main quantitative methods available for the quantitative treatment of geochemical data, as well as:


### Prerequisites / notice
Prerequisites: Basics in physical chemistry are required and an overview equivalent to the bachelor course in atmospheric chemistry (lecture 701-0471-D1) is expected.

701-1233-00 V starts in the first week of the semester. The exercises 701-1233-00 U will start only in the 2nd week of the semester.

#### 402-0572-00L

**Aerosols I: Physical and Chemical Principles**

**W** 4 credits 2V+1U  M. Gysel, U. Baltensperger, H. Burkacher

**Abstract**

Aerosols I deals with basic physical and chemical properties of aerosol particles. The importance of aerosols in the atmosphere and in other fields is discussed.

**Objective**

Knowledge of basic physical and chemical properties of aerosol particles and their importance in the atmosphere and in other fields.

**Content**

physical and chemical properties of aerosols, aerosol dynamics (diffusion, coagulation...), optical properties (light scattering, absorption, extinction), aerosol production, physical and chemical characterization.

**Lecture notes**

material is distributed during the lecture

**Literature**


#### Climate History and Paleoclimatology

**Number**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4049-00L</td>
<td>Conceptual and Quantitative Methods in Geochemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>O. Bachmann, M. Schönächler, D. Vance</td>
</tr>
<tr>
<td></td>
<td><strong>For this course the successful completion of the BSc-</strong></td>
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<td></td>
<td><strong>course &quot;Geochemistry&quot; (651-3400-00L) is a condition.</strong></td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>This course will introduce some of the main quantitative methods available for the quantitative treatment of geochemical data, as well as the main modelling tools. Emphasis will both be on conceptual understanding of these methods as well as on their practical application, using key software packages to analyse real geochemical datasets.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Development of a basic knowledge and understanding of the main tools available for the quantitative analysis of geochemical data.</td>
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<td></td>
<td>The following approaches will be discussed in detail: major and trace element modelling of magmas, with application to igneous systems; methods and statistics for calculation of isochrons and model ages; reservoir dynamics and one-dimensional modelling of ocean chemistry; modelling speciation in aqueous (hydrothermal, fresh water sea water) fluids.</td>
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<td>We will discuss how these methods are applied in a range of Earth Science fields, from cosmochemistry, through mantle and crustal geochemistry, volcanology and igneous petrology, to chemical oceanography.</td>
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<td>A special emphasis will be put on dealing with geochemical problems through modeling. Where relevant, software packages will be introduced and applied to real geochemical data.</td>
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<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
<td></td>
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<td></td>
<td>Slides of lectures will be available.</td>
</tr>
<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
<td></td>
<td></td>
<td></td>
<td>Pre-requisite: Geochemistry (651-3400-00L), Isotope Geochemistry and Geochronology (651-3501-00L).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>651-4057-00L</th>
<th>Climate History and Palaeoclimatology</th>
<th>W</th>
<th>3</th>
<th>2G</th>
<th>S. Bernasconi, B. Austin Gonzalez, A. Fernandez Bremer, A. Gilli</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>The course &quot;Climate history and paleoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in paleoclimatological research.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmospheric chemistry, tectonics- through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate &quot;proxies&quot;, he or she will be able to estimate quality of marine and terrestrial sedimentary paleoclimatic archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<td>Cretaceous greenhouse climate</td>
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<td>Cenozoic Cooling</td>
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<td>Pliocene warmth</td>
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<td>Glacial and Interglacials</td>
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<td>The last deglaciation(s)</td>
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<td>The Younger Dryas</td>
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<td>The Younger Dryas</td>
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<td></td>
<td>Holocene climate - climate and societies</td>
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<td>Holocene climate - climate and societies</td>
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</tbody>
</table>
Additional literature is presented during the course. Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and associated feedbacks for the climate system.

Lecturers
Hydrology II
Z. Frei

The students can understand the role of land processes and associated feedbacks for the climate system.

Lecture notes
Powerpoint slides will be made available

Prerequisites / notice
Prerequisites: Introductory lectures in atmospheric and climate science

701-1253-00L Analysis of Climate and Weather Data
W 3 credits 2G C. Frei

Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

Objective
Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

Content
Introduction into the theoretical background and the practical application of methods of data analysis in meteorology and climatology.

Topics: exploratory methods, hypothesis tests, analysis of climate trends, measuring the skill of climate and forecasting models, analysis of extreme events, principal component analysis and maximum covariance analysis.

The lecture also provides an introduction into R, a programming language and graphics tool frequently used for data analysis in meteorology and climatology. During hands-on computer exercises the student will become familiar with the practical application of the methods.

Lecture notes
Documentation and supporting material include:
- documented view graphs used during the lecture
- exercise sets and solutions
- R-packages with software and sample datasets for exercise sessions

All material is made available via the lecture web-page.

Literature
Suggested literature:

Prerequisites / notice
Prerequisites: Atmosphäre, Mathematik IV: Statistik, Anwendungsnahes Programmieren.

102-0237-00L Hydrology II
W 3 credits 2G P. Burlando, S. Fattichi

The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

Objective
Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.

Content

Lecture notes
Parts of the script for “Hydrology I” are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

Literature
Additional literature is presented during the course.

651-4053-05L Boundary Layer Meteorology
Z 4 credits 3G M. Rotach, P. Calanca

The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

Objective
Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

Content
- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

Lecture notes
available (i.e. in English)

Literature

Prerequisites / notice
Umwelt-Fluidynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science.

Autumn Semester 2016

Colloquia and Seminars

Number
Title
ECTS
Hours
Lecturers

701-1211-01L Master's Seminar: Atmosphere and Climate
O 3 credits 2S H. Joos, O. Stebler, F. Tummon, M. A. Wüest
Abstract
In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other’s work.

Objective
Training scientific writing skills.

Content
In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other’s work.

Prerequisites / notice
Attendance is mandatory.

701-1211-02L Master’s Seminar: Atmosphere and Climate 2

Abstract
In this seminar scientific project management is introduced and applied to your master project. The course concludes with a presentation of your project including an overview of the science and a discussion of project management techniques applied to your thesis project.

Objective
Apply scientific project management techniques to your master project.

Content
In this seminar scientific project management is introduced and applied to your master project. The course concludes with a presentation of your project including an overview of the science and a discussion of project management techniques applied to your thesis project.

Prerequisites / notice
Attendance is mandatory.

701-1213-00L Introduction Course to Master Studies Atmosphere and Climate

Abstract
New master students are introduced to the atmospheric and climate research field through keynotes given by the programme's professors. In several self-assessment and networking workshops they get to know each other and find their position in the science.

Objective
The aims of this course are i) to welcome all students to the master program and to ETH, ii) to acquaint students with the faculty teaching in the field of atmospheric and climate science at ETH and at the University of Bern, iii) that the students get to know each other and iv) to assess needs and discuss options for training and education of soft-skills during the Master program and to give an overview of the study options in general.

651-4095-01L Colloquium Atmosphere and Climate 1

Abstract
The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

Objective
The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

651-4095-02L Colloquium Atmosphere and Climate 2

Abstract
The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

Objective
The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

651-4095-03L Colloquium Atmosphere and Climate 3

Abstract
The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

Objective
The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

Electives

Climate Processes and Feedbacks

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
701-1221-00L | Dynamics of Large-Scale Atmospheric Flow | W | 4 credits | 2V+1U | H. Wernli, S. Pfahl

Abstract
Understanding the dynamics of large-scale atmospheric flow

Objective
Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes
Dynamical Meteorology

Literature
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Prerequisites / notice
Physics I, II, Environmental Fluid Dynamics

651-4057-00L | Climate History and Palaeoclimatology | W | 3 credits | 2G | S. Bernasconi, B.Ausin Gonzalez, A. Fernandez Bremer, A. Gilli

Abstract
The course "Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in palaeoclimatic research."
### Objective
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary paleoclimatic archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

### Content
- Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.
- Geological time, stratigraphy, geological archives, climate archives, paleoclimatic proxies
- Climate through geological time: "lessons from the past"
- Cretaceous greenhouse climate
- The Late Paleocene Thermal Maximum (PETM)
- Genozoic Cooling
- Onset and Intensification of Southern Hemisphere Glaciation
- Onset and Intensification of Northern Hemisphere Glaciation
- Pliocene warmth
- Glacial and Interglacials
- Millennial-scale climate variability during glaciations
- The last deglaciation(s)
- The Younger Dryas
- Holocene climate - climate and societies

### Atmospheric Composition and Cycles

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1235-00L</td>
<td>Cloud Microphysics</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>U. Lohmann, Z. A. Kanji</td>
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<tr>
<td></td>
<td>Number of participants limited to 16.</td>
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<tr>
<td>Abstract</td>
<td>Clouds are a fascinating atmospheric phenomenon central to the hydrological cycle and the Earth’s climate. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes.</td>
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<tr>
<td>Objective</td>
<td>The learning objective of this course is that students understand the formation of clouds and precipitation and can apply learned principles to interpret atmospheric observations of clouds and precipitation.</td>
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<tr>
<td>Content</td>
<td>see: <a href="http://www.iac.ethz.ch/edu/courses/master/modules/cloud-microphysics.html">http://www.iac.ethz.ch/edu/courses/master/modules/cloud-microphysics.html</a></td>
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<tr>
<td>Lecture notes</td>
<td>This course will be designed as a reading course in 1-2 small groups of 8 students maximum. It will be based on the textbook below. The students are expected to read chapters of this textbook prior to the class so that open issues, fascinating and/or difficult aspects can be discussed in depth.</td>
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<td>Prerequisites / notice</td>
<td>Target group: Master students in Atmosphere and Climate</td>
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<tr>
<td>102-0635-01L</td>
<td>Air Pollution Control</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>B. Buchmann, P. Hofer</td>
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<tr>
<td>Abstract</td>
<td>The lecture provides in the first part an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and their impact on air quality. The second part covers different strategies and techniques for emission reduction. The basic knowledge is deepened by the discussion of specific air pollution problems of today's society.</td>
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<td>Objective</td>
<td>The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost.</td>
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<tr>
<td>Content</td>
<td>Part 1 Emission, Immission, Transmission Fluxes of pollutants and their environmental impact - physical and chemical processes leading to emission of pollutants - mass and energy of processes - Emission measurement techniques and concepts - quantification of emissions from individual and aggregated sources - extent and development of the emissions (Switzerland and global) - propagation and transport of pollutants (transmission) - meteorological parameters influencing air pollution dispersion - deterministic and stochastic models, describing the air pollution dispersion - dispersion models (Gaussian model, box model, receptor model) - measurement concepts for ambient air (immission level) - extent and development of ambient air mixing ratios - goal and instrument of air pollution control</td>
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<td>Part 2 Air Pollution Control Technologies -The reduction of the formation of pollutants is done by modifying the processes (pro-cess-integrated measures) and by different engineering operations for the cleaning of waste gas (downstream pollution control). It will be demonstrated, that the variety of these procedures can be traced back on the application of a few basic principles of physical chemistry. - Procedures for the removal of particles (inertial separator, filtration, electrostatic pre-cipitators, scrubbers) with their different mechanisms (field forces, impaction and diffu-sion processes) and the modelling of these mechanisms. - Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biological conversions). - Discussion of the technical possibilities to solve the actual air pollution problems.</td>
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<tr>
<td>Lecture notes</td>
<td>Brigitte Buchmann, Air pollution control, Part I - Peter Hofer, Air pollution control, Part II - Lecture slides and exercises</td>
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</table>
**Boundary Layer Meteorology**

**Number** 651-4053-05L

**Title** Boundary Layer Meteorology

**Type** W

**ECTS** 4 credits

**Hours** 3G

**Lecturers** M. Rotach, P. Calanca

**Abstract** The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

**Objective** Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

**Content**
- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

**Lecture notes** available (i.e. in English)

**Literature**

**Prerequisites / notice** Umwelt-Fluiddynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

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**Hydrology and Water Cycle**

**Number** 701-0535-00L

**Title** Environmental Soil Physics/Vadose Zone Hydrology

**Type** W

**ECTS** 3 credits

**Hours** 2G+2U

**Lecturers** D. Or

**Abstract** The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

**Objective** Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges
### Content

- **Weeks 1 to 3:** Physical Properties of Soils and Other Porous Media  
  Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

- **Soil Water Content and its Measurement - Definitions:** measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

- **Weeks 4 to 5:** Soil Water Retention and Potential (Hydrostatics)  
  The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

- **Demo-Lab:** Laboratory methods for determination of soil water characteristic curve (SWC), sensor propagation

- **Weeks 6 to 9:** Water Flow in Soil - Hydrodynamics:  
  Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

  **Lab #1:** Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

  **Part 2:** Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

  **Midterm exam**

  **Lab #2:** Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

  **Part 3:** Use of Hydrus model for simulation of unsaturated flow

- **Week 10 to 11:** Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

- **Week 12 to 13:** Solute Transport in Soils  
  Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

  **Lab #3:** Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

- **Additional topics:**
  - Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.
  - Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

#### Lecture notes

- Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)
- http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

#### Literature

- Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

### 102-0287-00L Fluvial Systems W 3 credits 2G P. Molnar

<table>
<thead>
<tr>
<th>Abstract</th>
<th>Content</th>
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<tbody>
<tr>
<td>The course presents a view of the processes acting on and shaping the landscape and the fluvial landforms that result. The fluvial system is viewed in terms of the production and transport of sediment on hillslopes, the structure of the river network and channel morphology, fluvial processes in the river, riparian zone and floodplain, and basics of catchment and river management.</td>
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<tr>
<td>The course has two fundamental aims: (1) it aims to provide environmental engineers with the physical process basis of fluvial system change, using the right language and terminology to describe landforms; and (2) it aims to provide quantitative skills in making simple and more complex predictions of change and the data and models required.</td>
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<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Literature</th>
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<tr>
<td>There is no script.</td>
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<tr>
<td>The course materials consist of a series of 13 lecture presentations and notes to each lecture. The lectures were developed from textbooks, professional papers, and ongoing research activities of the instructor. All material is on the course webpage.</td>
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<tr>
<th>Prerequisites / notice</th>
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<tr>
<td>Prerequisites: Hydrology 1 and Hydrology 2 (or contact instructor).</td>
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</table>

### 651-2915-00L Seminar in Hydrology Z 0 credits 1S P. Burlando, J. W. Kirchner, S. Löw, D. Or, C. Schär, M. Schirmer, S. I. Seneviratne, M. Stöckli, C. H. Stamm, University lecturers

### 651-4023-00L Groundwater W 4 credits 3G M. O. Saar, X.Z. Kong

<table>
<thead>
<tr>
<th>Abstract</th>
<th>Objective</th>
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<tbody>
<tr>
<td>The course provides an introduction into quantitative analysis of groundwater flow and solute/heat transport. It is focussed on understanding, formulating, and solving groundwater flow and solute/heat transport problems.</td>
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<tr>
<td>a) Students understand the basic concepts of groundwater flow and solute/heat transport processes and boundary conditions.</td>
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<tr>
<th>Prerequisites / notice</th>
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<tbody>
<tr>
<td>Students are able to understand and apply simple analytical and/or numerical solutions to fluid flow and solute/heat transport problems.</td>
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</tbody>
</table>
1. Introduction to groundwater problems. Concepts to quantify properties of aquifers.
2. Flow equation. The generalised Darcy law.
3. The water balance equation.
5. Analytical solutions to flow problems I
6. Analytical solutions to flow problems II
7. Finite difference solution to flow problems.
12. Analytical solutions to transport problems I.
13. Analytical solutions to transport problems II

Lecture notes
Handouts of slides.

Literature
de Marsily G., Quantitative Hydrogeology, Academic Press, 1986

Additional Elective Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1237-00L</td>
<td>Solar Ultraviolet Radiation</td>
<td>W</td>
<td>1 credit</td>
<td>1V</td>
<td>J. Gröbner</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture will introduce the student to the thematics of solar ultraviolet radiation and its effects on the atmosphere and the biosphere. The lecture will cover the modeling and the measurement of solar ultraviolet radiation. The instruments used for solar radiation measurements will also be introduced.

**Objective**
The lecture should enable the student to understand the specific problematics related to solar ultraviolet radiation and its interaction with the atmosphere and the biosphere.
Content

1) Einführung in die Problematik Motivation
   Begriffe (UV-C, UV-B, UV-A, ...)
   Einfluss der UV Strahlung auf Biosphäre (Mensch, Tier, Pflanzen)
   Positive und schädliche Effekte
   Wirkungsspektrum, Konzept, Beispiele
   UVIndex

2) Geschichtlicher Rückblick
   Rayleigh - Himmelsblau
   1907: Dorno, PMOD
   1970: Bener, PMOD
   1980: Berger, Erythemal sunburn meter
   1990-: State of the Art

3) Extraterrestrische UV Strahlung
   Spektrum
   Energieverteilung
   Variabilität (Spektral, zeitlich, relativ zu Totalstrahlung)
   Satellitenmessungen, Übersicht

4) Einfluss der Atmosphäre auf die solare UV Strahlung
   Atmosphärenaufbau
   Beinflussende Parameter (Ozon, Wolken, ...)
   Ozon, Stratosphärisches versus troposphärisches
   Geschichte: Ozondépletion, Polare Ozonlöcher und Einfluss auf die UV Strahlung
   Wolken
   Aerosole
   Rayleighstreuung
   Trends (Ozon, Wolken, Aerosole)
   Radiation Amplification Factor (RAF)

5-6) Strahlungstransfer
   Strahlungstransfergleichung
   Modellierung, DISORT
   LibRadtran, TUV, FASTRT
   Parameter
   Sensitivitätssstudien
   Vergleiche mit Messungen
   3-D Modellierung (MYSTIC)
   Beer-Lambert Gesetz

7) Strahlungsmessungen
   Instrumente zur Strahlungsmessung
   Messgrössen: Irradiance (global, direct, diffus), radiance, aktinischer Fluss
   Horizontale und geneigte Flächen
   Generelle Problematik: Freiluftmessungen...
   Qualitätssicherung

8) Solare UV Strahlungsmessungen
   Problematik: Dynamik, Spektrale Variabilität, Alterung
   Stabilität
   Spezifische Instrumente: Filterradiometer, Spektroradiometer, Dosimetrie
   Übersicht Aufbau und Verwendung

9-10) Solare UV Strahlungsmessgeräte
   Spektroradiometer, Filterradiometer (Breit und schmalbandig)
   Charakterisierung
   Kalibriermethoden (Im Labor, im Feld)
   Qualitätssicherung, Messkampagnen

11-12) Auswerteverfahren
   Atmosphärische Parameter aus Strahlungsmessungen
   Ozon, SO2
   Albedo (Effektiv versus Lokal)
   Aerosol Parameter (AOD, SSA, g, Teilchenverteilungen)
   Zusammenspiel Messungen - Modellierung
   Aktinische UV-Strahlungsfliisse und Bestimmung von atmosphärischen Photolysefrequenzen

13) UV Klimatologie
   Trends
   UV Klimatologie durch Messnetze
   UV Klimatologie durch Satellitenmessungen am Beispiel von TOMS
   Modellierung am Beispiel Meteosat-JRC
   UV Rekonstruktionen

14) Aktuelle Forschungen
   Internationale Projekte, Stand der Forschung

Abstract
This course gives an introduction to programming in FORTRAN95, and is suitable for students who have only minimal programming experience. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts.

Objective
FORTRAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

Lecture notes
See http://jupiter.ethz.ch/~pjt/FORTRAN/FortranClass.html

651-4273-00L  Numerical Modelling in Fortran  W  3 credits  2V  P. Tackley

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1505 of 1571
The course is under development. Lecture materials will be distributed as they become available.

Lecturers

This course gives an introduction to programming in FORTRAN95, and is suitable for students who have only minimal programming experience. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts.

Objective

FORTRAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

Content

The project consists of writing a Fortran program to solve a problem agreed upon between the instructor and student; the topic is often related to (and helps to advance) the student's Masters or PhD research. The project is typically started towards the end of the main Fortran class when the student has acquired sufficient programming skills, and is due by the end of Semesterprüfung week.

Lecture notes

See http://jupiter.ethz.ch/~pj/FORTRAN/FortranProject.html

## Major in Biogeochemistry and Pollutant Dynamics

### Biogeochemical Processes

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1313-00L</td>
<td>Isotopic and Organic Tracers in Biogeochemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>R. Kipfer, S. Ladd</td>
</tr>
<tr>
<td>701-1315-00L</td>
<td>Biogeochemical Trace Elements</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Voegelin, M. Etiqie, L. Winkel</td>
</tr>
<tr>
<td>701-1316-00L</td>
<td>Physical Transport Processes in the Natural Environment</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>J. W. Kirchner</td>
</tr>
</tbody>
</table>

### Applications

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
</tr>
</tbody>
</table>

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1506 of 1571
The course offers a practical introduction into the investigation of the biogeochemistry of trace elements. Laboratory experiments are performed to study a selected environmental process. Advanced techniques for the analysis of total element contents and element speciation are used. The experimental findings are interpreted and discussed in their environmental context.

Objective
The objective of this course, is to offer students a practical introduction into the investigation of the biogeochemistry of trace elements. During the course, students will become familiar with some of the key experimental approaches typically used in the investigation of the biogeochemistry of trace elements. In addition, students will learn to use different advanced analytical techniques to measure the total content and the speciation of trace elements in both liquid and solid samples. The students will interpret and discuss their experimental findings in the context of the studied environmental system.

Content
Laboratory experiments are designed and performed to study the interplay of various biogeochemical processes in a specific environmental system. Moreover, the effect of these processes on the biogeochemical cycling of trace elements in the environment will be considered. Advanced techniques for the analysis of total element contents and element speciation are used. The experimental findings are interpreted and discussed in the context of the the environmental system under investigation.

Lecture notes
Selected handouts will be distributed during the course.

Literature
All necessary literature will be uploaded to the ILIAS repository during the course.

Methods and Tools: Lab Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1331-00L</td>
<td>Trace Elements Laboratory</td>
<td>W</td>
<td>3 credits</td>
<td>4P</td>
<td>A. L. Atkins, K. Barmettler</td>
</tr>
</tbody>
</table>

Abstract
The course offers a practical introduction into the investigation of the biogeochemistry of trace elements. Laboratory experiments are performed to study a selected environmental process. Advanced techniques for the analysis of total element contents and element speciation are used. The experimental findings are interpreted and discussed in their environmental context.

Objective
The objective of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.

Content
From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group.

Lecture notes
None

Literature
Will be identified based on the chosen topic.

Prerequisites / notice
Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.

Methods and Tools: Lab Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1351-00L</td>
<td>Nanomaterials in the Environment</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>B. Nowack, T. Bucheli</td>
</tr>
</tbody>
</table>

Abstract
The lecture provides an overview on the behavior and effects of engineered nanomaterials in the environment as far as they are currently understood. The course will cover definitions, analysis, fate in technical and natural systems, effects (nano-ecotoxicology) and environmental risk assessment of nanomaterials.

Objective
- Successful application of knowledge gained in the traditional disciplines of environmental sciences (e.g. biogeochemistry, environmental chemistry) to elucidate nanomaterial fate and behavior in the environment
- Identify key parameters of nanomaterials that potentially influence their environmental fate and behavior
- Get acquainted with the most common analytical tools for the quantification of nanomaterials in the environment
- Critical assessment of current state of research in this juvenile field, including the sometimes controversial literature data

Content
Topics
- Definitions; nano-effects; engineered, natural and incidental nanoparticles
- Sources and release; Material flow modeling
- Analysis in environmental samples
- Fate in technical systems: water treatment, waste incineration
- Fate in the environment: water and soil
- Effects: nano-ecotoxicology
- Environmental risk assessment

Group work
Case studies about specific nanomaterials in environmental systems, topics will be provided
Written report submitted and presentation at the end of the lecture

Lecture notes
Handouts will be provided

Literature
will be provided during lecture
Isotopic and Organic Tracers Laboratory  

**Abstract**
This course will illustrate how different tracers and isotopes are used in natural systems. Here especially the processes (transformation, timescales) that take place and can be revealed by tracers/isotopes will be demonstrated but also flux rates will be calculated using different tracers.

**Objective**
Students know how to use tracers/isotopes to investigate/understand ecosystems
- They will understand the methods and analytical devices related to tracer/isotope work
- Have a feeling for timescales on which natural processes occur
- Students will be able to apply different sampling techniques in aquatic sciences

**Content**
Basics:
- O,H isotopes as tracers for mixing in aquatic systems
- Carbon isotopes as tracer for methane oxidation
- 210Pb, 137Cs as a tracer for sedimentation rate/mixing
- SF6, Neon, He as tracers for exchange processes at the air/water interface

Case assessment:
- Sampling of a Swiss lake (Rotsee)
- Sampling techniques for different elements
- Sample preparation for different techniques
- Measurements at isotope mass spectrometer/gamma counter
- Interpretation of results from the special sampling campaign and in a broader context

Forest Soils - Functions and Responses to Environmental Changes

**Abstract**
The students are measuring carbon and nutrient fluxes in forest soils under a changing climate and land-use. In laboratory and field experiments, they are manipulating climatic conditions (temperature, drought) and quantify the response of C and N fluxes in soils, and plant-soil interactions. The results will be interpreted and discussed in the context of changes in climate and land-use.

**Objective**
The students get first-hand experience with field and laboratory methods to measure carbon and nutrient fluxes. They shall learn about physico-chemical properties of Swiss forest soils and how these properties determine the ecological functions of soils and their response to environmental changes. Finally the students shall interpret, discuss and present their experimental data.

**Content**
1. Introduction to the ecological functions of Swiss forest soils
2. Measurement of soil CO2 efflux, carbon and nutrient leaching in a forest soil
3. Sampling and preparation of litterand soil samples from selected soil profiles under different land-uses
4. Setting-up laboratory experiments in microcosms. Measurement of soil respiration and leaching of carbon, nutrients and/or contaminants in climate chambers under different environmental conditions.
5. Analyses of litter, soil, and soil water for selected physical and chemical properties
6. Interpretation and final presentation of data

**Lecture notes**
A manual will be distributed during the course.

**Literature**
Selected publications will be distributed during the course.

Soil Solids Laboratory

**Abstract**
The main part of the course is the investigation of real samples of soils/sediments in the lab working in groups. A brief theoretical introduction into the overall principle and the meaning of physical, mineralogical and chemical parameters of soils and sediments and into each analytical method for their investigation will be given in advance.

**Objective**
Upon successful completion of this course students are able to:
- describe structural, mineralogical and chemical properties of the inorganic solid part of soils and sediments,
- propose and apply different advanced methods and techniques to measure these properties,
- critically assess the data and explain the relationships between them,
- communicate the results in a scientific la report.

**Content**
Basic introduction to mineralogy and texture of soils
- Analytical techniques
- Practical exercises in sample preparation
- Measurement and evaluation of the data:
  - physical parameters (grain size distribution, surface, densities, porosity, (micro)structur)
  - mineralogical/geochemical parameters (quantitative mineralogical composition, thermal analysis, cation exchange etc.)

**Lecture notes**
Selected handouts will be distributed during the course.

**Literature**

**Prerequisites / notice**
Number of participants limited to 12.

Environmental Measurement Laboratory

**Abstract**
Measurements are the sole judge of scientific truth and provide access to unpredictable information, enabling the characterization and monitoring of complex terrestrial systems. Based on lectures and field- and laboratory training the students learn to apply modern methods to determine forest inventory parameters and to measure subsurface properties and processes.

**Objective**
- explain functioning of sensors that are used for characterization of landscapes and terrestrial systems
- select appropriate measurement methods and sampling design to quantify key variables and processes in the subsurface
- deploy sensors in the field and maintain sensor network
- interpret collected laboratory and field data and report main conclusions deduced from measurements

**Prerequisite:** Lecture Biogeochemistry of Trace Elements.
The ability to critically evaluate original (scientific) literature and to summarize the information in a succinct manner is an important skill for any student. This course aims to practise this ability, requiring each student to write a term paper on a topic of relevance for research in the areas of Biogeochemistry and Pollutant Dynamics.

Content

Objective

Each student is expected to write a paper with a length of approximately 15 pages. The students can choose from a list of topics prepared by the supervisors, but the final topic will be determined based on a balance of choice and availability. The students will be guided and advised by their advisor throughout the term. The paper itself should contain the following elements: Motivation and context of the given topic (25%), Concise presentation of the state of the science (50%), Identification of open questions and perhaps outline of opportunities for research (25).

In addition, the accurate use of citations, attribution of ideas, and the judicious use of figures, tables, equations and references are critical components of a successful paper. Specialized knowledge is not expected, nor required, neither is new research.

Each term paper will be made publically available after each student had the opportunity to make revisions. There is no final exam. Grade is assigned based on the quality of the presentation and ensuing discussion.

Students are expected to take Term Paper Writing and Term Paper Seminar classes in sequence.

Semester Paper and Seminar

Term Paper 2: Seminar

Prerequisite: Term Paper 1: Writing (701-1303-00L).

Term Paper 1: Writing

Prerequisite: Term Paper 1: Writing (701-1303-00L).

Objective

Each student presents the results of the term paper to the other students and advisors and responds to questions and comments from the audience.

Content

The ability to critically evaluate a well-defined set of research subjects, and to summarize the findings concisely in a paper of scientific quality. The paper will be evaluated based on its ability to communicate an understanding of a topic, and to identify key outstanding questions.

Results from this term paper will be presented to the fellow students and involved faculty in the following term (Term paper seminars class).

Lecture notes

Literature

Prerequisites / notice

The term papers will be made publically available after each student had the opportunity to make revisions.

There is no final exam. Grade is assigned based on the quality of the presentation and ensuing discussion.

Semester Paper and Seminar

Term Paper 2: Seminar

Prerequisite: Term Paper 1: Writing (701-1303-00L).

Term Paper 1: Writing

Prerequisite: Term Paper 1: Writing (701-1303-00L).

Objective

Each student presents the results of the term paper to the other students and advisors and responds to questions and comments from the audience.

Content

The ability to critically evaluate original (scientific) literature and to summarize the information in a succinct manner is an important skill for any student. This course aims to practise this ability, requiring each student to write a term paper on a topic of relevance for research in the areas of Biogeochemistry and Pollutant Dynamics.

Content

The ability to critically evaluate original (scientific) literature and to summarize the information in a succinct manner is an important skill for any student. This course aims to practise this ability, requiring each student to write a term paper on a topic of relevance for research in the areas of Biogeochemistry and Pollutant Dynamics.

Content

The ability to critically evaluate original (scientific) literature and to summarize the information in a succinct manner is an important skill for any student. This course aims to practise this ability, requiring each student to write a term paper on a topic of relevance for research in the areas of Biogeochemistry and Pollutant Dynamics.

Content
### 701-1427-00L Experimental Evolution

**Abstract**

Students will analyze experimental evolution literature covering a wide range of questions, species and types of analysis and will lead discussions of this literature. Students will develop a written project proposal for a novel evolution experiment (or a novel analysis of a published experiment) to address an unanswered question and will also deliver an oral presentation of the project proposal.

**Objective**

Course objectives:

- i) become familiar with a diverse sample of experimental evolution literature,
- ii) gain understanding of the strengths and limitations of experimental evolution for addressing evolutionary questions relative to other forms of evolutionary analysis, and
- iii) gain the ability to effectively design and analyze evolution experiments that address fundamental or applied questions in evolutionary biology.

**Content**

Experimental evolution is a powerful and increasingly prominent approach to investigating evolutionary processes. Students will analyze experimental evolution literature covering a diverse range of topics, species and types of analysis and will lead discussions of this literature. Students will develop a written project proposal for a novel evolution experiment (or a novel analysis of a published experiment) to address an unanswered question and will also deliver an oral presentation of the project proposal. Evaluation will be based on a combination of participation in and leadership of literature discussions, in-class exams, and oral and written presentations of the project proposal.

**Literature**

Primary research papers and review articles.

**Prerequisites / notice**

- 701-0245-00 Introduction to Evolutionary Biology (or equivalent).

### 701-1453-00L Ecological Assessment and Evaluation

**Abstract**

The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

**Objective**

Students will be able to:

1) critically consider biological data books and local, regional, and national inventories;
2) evaluate the validity of ecological criteria used in decision making processes;
3) critically appraise the handling of ecological data and criteria used in the process of evaluation;
4) perform an ecological evaluation project from the field survey up to the decision making and planning.

**Literature**

Basic literature and references are listed on the webpage.

**Prerequisites / notice**

The course structure changes between lecture parts, seminars and discussions. The didactic atmosphere is intended as working group.

- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbiodäologie

### 701-1613-01L Advanced Landscape Research

**Abstract**

This course introduces landscapes as socially perceived, spatially and temporally dynamic entities that are shaped by natural and societal factors. Concepts and qualitative and quantitative methods to study landscapes from an ecological, societal and historical perspective are presented. In a term paper students work on a landscape-related topic of their choice.

**Objective**

Students will:

- learn about concepts and methods to quantify structural and functional connectivity in landscapes, particularly
- learn about concepts and methods in scenario-based land-use change modelling
- approach an understanding of landscape as perceived environment
- be introduced to the topic of landscape genetics and its benefits and (current) limitations for applied conservation
- understand the role of landscape for human well-being
- be introduced into approaches of actively influencing attitudes and behavior as well as related scientific evaluation
- make use of various historical sources to study landscapes and their dynamics
- interpret landscapes as a result of ecological constraints and anthropogenic activities.
1. Encompassing concepts and approaches

- European Landscape Convention (ELC)
- Ecosystem Services (ES): introduction and critical evaluation

Thematic topics

2. Ecological approach:
- green infrastructure (e.g., ecological conservation areas)
- landscape connectivity
- landscape genetics and management applications
- concepts of specific quantitative methods: least cost paths, resistance surfaces, Circuitscape, networks (Conefor), land-use change models, various statistical methods

3. Social-science approach:
- principle of landscape as perceived and connoted environment
- theories on landscape preference and place identity
- role of landscapes for recreation, health and well-being
- intervention approaches for influencing attitudes and related behavior
- methods of investigating the human-landscape relationship and evaluating interventions

4. Historical approach:
- land use history of Switzerland (agricultural history, forest and woodland history)
- historical legacies of land use in landscapes and ecosystems
- historic-ecological approaches and applications

5. Land change science:
- modelling future land-use (CLUE, other scenario-based models)
- landscape functions and services

Lecture notes

Handouts will be available in the course and for download

Prerequisites / notice

Basic Landscape Ecology courses at Bachelor level

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**701-1631-00L Foundations of Ecosystem Management**

**Abstract**

This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

**Objective**

Students should be able to

a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.

b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.

**Content**

Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

**Lecture notes**

No Script

**Literature**


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**701-1661-00L Conservation and Development in Complex Landscapes**

**Abstract**

The field course in Belize will develop an understanding of, and solutions to, issues of landscape management relevant to conservation and natural resources. Students will be expected to integrate skills in quantitative natural science with social science approaches in real world, and hence highly complex, settings.

**Objective**

To address complex multi-dimensional environmental problems through the application of interdisciplinary and transdisciplinary skills.
**Research Seminar: Ecological Genetics**

This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature with community processes to understand the mosaic of habitat types, their distribution, form, and function.

**Day 2: The ecology of natural resources**

Students will begin to explore how people use forest resources, ranging from timber, to a variety of non-timber forest products, and animals for hunting. This will lead to an evaluation of threats to species and habitats, and hence set the scene for subsequent work.

**Day 3: Familiarisation with landscape scale dynamics**

We will explore the land uses in the landscape in the vicinity of Shipstern and Freshwater creeks. This will encompass a range of land uses, including small scale to large scale agriculture, extractive forest reserves, and protected forests. In the process the students will gain a better understanding of the pressures on land and forests, and a chance to meet some of the local stakeholders involved in land use transformations.

**Days 4 & 5: Problem conceptualisation**

Working with reserve managers and local stakeholders the students will develop a conceptual understanding of the key problems in the region, including the underlying drivers of change.

**Days 6-9: Integrative analysis**

Students, working in small groups, will analyse selected natural resource problems in greater depth. Options include biodiversity responses to habitat fragmentation, conservation management of mangrove and coral reef systems, restoration ecology, community forest management, and tourism development, among others. Students will have opportunities to collect original data across natural and social sciences, and will use different modelling approaches to explore future development trajectories.

**Day 10-11: Synthesis and presentation of results**

Research will be synthesised and presented to the local management community of Shipstern and Freshwater Creek reserves. The course will conclude with an afternoon allocated to discussion and debriefing, including an appraisal of the challenges of addressing natural resource management issues in complex socioecological systems, and the lessons learned.

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**Advanced Concept Classes**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0263-01L</td>
<td><strong>Seminar in Evolutionary Ecology of Infectious Diseases</strong></td>
<td>W</td>
<td>3</td>
<td>G</td>
<td>D. Croll, S. Bonhoeffer, R. R. Regös</td>
</tr>
</tbody>
</table>

**Abstract**

Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.

**Objective**

This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

**Content**

A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

**Lecture notes**

Publications and class notes can be downloaded from a web page announced during the lecture.

**Literature**

Papers will be assigned and downloaded from a web page announced during the lecture.

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
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</tr>
</thead>
<tbody>
<tr>
<td>701-1409-00L</td>
<td><strong>Research Seminar: Ecological Genetics</strong></td>
<td>W</td>
<td>2</td>
<td>1S</td>
<td>A. Widmer, S. Fior</td>
</tr>
</tbody>
</table>

**Abstract**

In this research seminar we will critically discuss current topics in Ecological Genetics using publications from the leading scientific journals in this field.

**Objective**

It is our aim that participants gain insight into the current research topics and knowledge available in Ecological Genetics and learn to critically assess and appreciate scientific publications in this field.

**Lecture notes**

none

**Literature**

will be distributed

**Prerequisites / notice**

Active participation in the discussions is a prerequisite for this course.

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1471-00L</td>
<td><strong>Ecological Parasitology</strong></td>
<td>W</td>
<td>3</td>
<td>1+P</td>
<td>O. E. Seppälä, H. Hartikainen, J. Jokela</td>
</tr>
</tbody>
</table>

**Number of participants limited to 20.**

Enrollment is limited to Master students of the study programme Environmental Sciences majoring Ecology and Evolution and to Master students of the study programme Biology majoring Ecology and Evolution (Elective Compulsory Master Courses), time of enrolment is decisive.

It is possible to enroll until September 12. The registration will only be effective once confirmed.

**Abstract**

Course focuses on the ecology and evolution of macroparasites and their hosts. Through lectures and practical work, students learn about diversity and natural history of parasites, adaptations of parasites, ecology of host-parasite interactions, applied parasitology, and human macroparasites in the modern world.

**Objective**

1. Identify common macroparasites in aquatic organisms.
2. Understand ecological and evolutionary processes in host-parasite interactions.
3. Conduct parasitological research.

**Content**

Lectures:
1. Diversity and natural history of parasites (i.e. systematic groups and life-cycles).
2. Adaptations of parasites (e.g. evolution of life-cycles, host manipulation).
3. Ecology of host-parasite interactions (e.g. parasite communities, effects of environmental changes).
4. Applied parasitology (e.g. aquaculture and fisheries).
5. Human macroparasites (schistosomiasis, malaria).

Practical exercises:
1. Examination of parasites in fish (identification of species and description of parasite communities).
2. Examination of parasites in molluscs (identification and examination of host exploitation strategies).
3. Examination of parasites in amphipods (identification and examination of effects on hosts).

**Prerequisites / notice**

Foundations of Ecosystem Management

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**Landscape Genetics**

Number of participants limited to 14.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1676-01L</td>
<td><strong>Landscape Genetics</strong></td>
<td>W</td>
<td>2</td>
<td>3G</td>
<td>R. Holderegger, J. Bolliger, F. Gugerli</td>
</tr>
</tbody>
</table>
We will cover several topics where evolutionary thinking is relevant to understanding or treating infectious diseases. This includes: (i) determinants of pathogen host range and virulence, (ii) dynamics of host-parasite coevolution, (iii) pathogen adaptation to evade or suppress immune responses, (iv) antimicrobial resistance, (v) evolution-proof medicine. For each topic there will be a short (< 30 minutes) introductory lecture, before students independently research the primary literature and develop half a page of discussion points and questions, followed by interactive discussion in class.

**Objective**

Students will learn to (i) identify evolutionary explanations for the origins and characteristics of infectious diseases in a range of organisms and (ii) evaluate ways of integrating evolutionary thinking into improved strategies for treating infections of humans and animals. This will incorporate principles that apply across any host-pathogen interaction, as well as system-specific mechanistic information, with particular emphasis on bacteria and viruses.

**Content**

We will cover several topics where evolutionary thinking is relevant to understanding or treating infectious diseases. This includes: (i) determinants of pathogen host range and virulence, (ii) dynamics of host-parasite coevolution, (iii) pathogen adaptation to evade or suppress immune responses, (iv) antimicrobial resistance, (v) evolution-proof medicine. For each topic there will be a short (< 30 minutes) introductory lecture, before students independently research the primary literature and develop half a page of discussion points and questions, followed by interactive discussion in class.

**Prerequisites**

A basic understanding of evolutionary biology, microbiology or parasitology will be advantageous but is not essential.
Objective

Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods. Students will engage in discussion and critical analyses of relevant papers and present their evaluations in a seminar setting.

751-5101-00L Biogeochemistry and Sustainable Management

Abstract

This course focuses on the interactions between ecology, biogeochemistry and management of agro- and forest ecosystems, thus, coupled human-environmental systems. Students learn how human impacts on ecosystems via management or global change are mainly driven by effects on biogeochemical cycles and thus ecosystem functioning, but also about feedback mechanisms of terrestrial ecosystems.

Objective

Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and forest ecosystems, be able to analyze and evaluate the various impacts of different management practices under different environmental conditions, search literature, write and evaluate scientific reports, and be able to coordinate and work successfully in small (interdisciplinary) teams.

Content

Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate or soils vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

Lecture notes

Handouts will be available on the webpage of the course.

Literature

Will be discussed in class.

Prerequisites / notice

Prerequisites: Attendance of introductory courses in plant ecophysiology, ecology, and grassland or forest sciences. Course will be taught in English.

C. Scientific skills

Laboratory and Field Expertise

<table>
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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1425-01L</td>
<td>Genetic Diversity: Techniques</td>
<td>W</td>
<td>2 credits</td>
<td>2P</td>
<td>A. M. Minder Pfyl</td>
</tr>
<tr>
<td>701-1437-00L</td>
<td>Limnoecology</td>
<td>W</td>
<td>8 credits</td>
<td>10G</td>
<td>P. Spaak, F. Altermatt, T. Gonser, K. J. Räsänen, C. T. Robinson</td>
</tr>
</tbody>
</table>

Abstract

- **701-1425-01L Genetic Diversity: Techniques**
  - Registration until 17.10.2016.
  - This course provides training for advanced students (master, doctoral or post-doctoral level) in how to measure and collect genetic diversity data from populations, experiments, field and laboratory. Different DNA/RNA extraction, genotyping and gene expression techniques will be addressed. Choice of topic by demand and/or availability of data.
  - Objective: To teach and improve on standard and modern methods of genetic data collection. Examples are: use of pyrosequencing, expression analysis, SNP-typing, next-generation sequencing, etc.
  - A course for practitioners.
  - Content: After an introduction (one afternoon), students will have 3 weeks to work independently or in groups through different protocols. At the end of the whole group meets for another afternoon to present the techniques/results and to discuss the advantages and disadvantages of the different techniques. Techniques adressed are: RNA/DNA extractions and quality control, SNP genotyping, pyrosequencing, real-time qPCR.

- **701-1437-00L Limnoecology**
  - This course combines Limnology (the study of inland waters in its broad sense) with ecological and evolutionary concepts. It deals with rivers, groundwater and lakes.
  - Objective: During this course you will get an overview of the world's typical freshwater ecosystems. After this course you will be able to understand how aquatic organisms have adapted to their habitat and how the interactions (e.g. food web) between organisms work.
  - Content: During the experimental part of this course you will learn the principles of doing research to observe interrelations in aquatic ecosystems. You will measure and interpret biological and physical data (e.g. during experiments, field work) and present the collected knowledge. In short: apply the theoretical / lecture knowledge to field situations in a lake and river.

Lecture notes

Material will be handed out in the course.

Literature

Material will be handed out in the course.

Prerequisites / notice

Two afternoons are held in the class. The lab work will be done from the students according to their timetable, but has to be finished after 3 weeks. Effort is roughly 1-2 days per week, depending on the skills of the student.
### Expertise in Biological Diversity

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1437-01L</td>
<td>Practical Course Macroinvertebrates</td>
<td>W</td>
<td>2</td>
<td>2P</td>
<td>J. Jokela</td>
</tr>
</tbody>
</table>

**Abstract**
This course gives an overview of the typical aquatic macroinvertebrate groups in Switzerland. Beside a theoretical background on the different groups the focus is laid on the determination of the most important species groups and their identification traits, also using identification keys. Practical experience in benthic sampling techniques is collected during an excursion.

**Objective**
During this course you will get an overview of the typical aquatic macroinvertebrates in Switzerland and the common sampling techniques. After this course you will be able to identify the most important aquatic species groups at the level of order/family and know the most important identification traits. You will also be able to use identification literature commonly used in Switzerland.

**Content**
The taxonomic part will cover macroinvertebrates (e.g. Crustacean, aquatic insects). The goal is to get to know the most common aquatic taxa in Switzerland, to identify them with commonly used identification literature, and to get an idea how these organisms are used in research and practice. (language: German, translation of the most important things during the course possible)

**Lecture notes**
The field excursion takes place Tuesday 25.10.2016.

**Prerequisites / notice**
Course notes and power point presentations provided during the course.

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1437-02L</td>
<td>Practical Course Microinvertebrates and Cryptogames</td>
<td>W</td>
<td>2</td>
<td>2P</td>
<td>J. Jokela</td>
</tr>
</tbody>
</table>

**Abstract**
This course gives an overview of the typical aquatic microinvertebrate groups and cryptogames in Switzerland. Beside a theoretical background on the different groups the focus is laid on the recognition of the most important species groups and their indentification traits. Practical experience is collected during an excursion.

**Objective**
During this course you will get an overview of the typical aquatic microinvertebrates and algae in Switzerland. After this course you will know the most important aquatic species groups and the most important identification traits.

**Content**
The taxonomic part will cover microinvertebrates and cryptogames. The goal is to get to know the most common aquatic taxa in Switzerland, to identify them and to get an idea how these organisms are used in research and practice. (language: German, translation of the most important things during the course possible)

**Lecture notes**
The excursion takes place Thursday 13.10.2016 from 13-17.

**Prerequisites / notice**
The maximal participating number of students is 8 from D-USYS and 14 from D-BIOL. In case of too many students, those that simultaneously participate in the courses "701-1437-00 Limnoecology" and "701-1437-02 Bestimmungskurs aquatische Mikroinvertebraten und Kryptogamen" are given priority. Sign in until 15.9.2016, free places will be distributed 16.9.2016.

### Quantitative and Computational Expertise

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>701-1419-00L</td>
<td>Analysis of Ecological Data</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>S. Güsewell</td>
</tr>
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</table>

**Abstract**
This class provides students with an overview of techniques for data analysis used in modern ecological research, as well as practical experience in running these analyses with R and interpreting the results. Topics include linear models, generalized linear models, mixed models, model selection and randomization methods.

**Objective**
Students will be able to:
- describe the aims and principles of important techniques for the analysis of ecological data
- choose appropriate techniques for given problems and types of data
- evaluate assumptions and limitations
- implement the analyses in R
- represent the relevant results in graphs, tables and text
- interpret and evaluate the results in ecological terms

**Content**
- Linear models for experimental and observational studies
- Model selection
- Introduction to likelihood inference and Bayesian statistics
- Analysis of counts and proportions (generalised linear models)
- Models for non-linear relationships
- Grouping and correlation structures (mixed models)
- Randomisation methods

**Lecture notes**
Lecture notes and additional reading will be available electronically a few days before the course

**Literature**
Suggested books for additional reading (available electronically)

**Prerequisites / notice**
The course takes place over a period of nine days from Thursday 12.01 to Friday 20.01, with classes on 12, 13, 16, 17 and 18.01. and an exam in the morning of 20.01.

**Prerequisites**
- Basic statistical training (e.g. Mathematik IV in D-USYS): Data distributions, descriptive statistics, hypothesis testing, linear regression, analysis of variance
- Basic experience in data handling and data analysis in R

**Individual preparation**
Students without the required knowledge are asked to contact the lecturer before Christmas for support with individual preparation.

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<tr>
<td>701-1677-00L</td>
<td>Quantitative Vegetation Dynamics: Models from Tree to Globe</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>H. Bugmann, M. Huber, H. Lischke</td>
</tr>
</tbody>
</table>

**Abstract**
This course provides hands-on experience with models of vegetation dynamics across temporal and spatial scales. The underlying principles, assets and trade-offs of the different approaches are introduced, and students work in a number of small projects with these models to gain first-hand experience.
Objective
Students will:
- be able to understand, assess and evaluate the fundamental properties of dynamic systems using vegetation models as case studies
- obtain an overview of dynamic modelling techniques from the individual plant to the global level
- understand the basic assumptions of the various model types, which dictate the skill and limitations of the respective model
- be able to work with such model types on their own
- appreciate the methodological basis for impact assessments of future climate change and other environmental changes on ecosystems.

Content
Models of individuals
- Deriving single-plant models from inventory measurements
- Plant models based on 'first principles'
- Models at the stand scale
  - Simple approaches: matrix models
  - Competition for light and other resources as central mechanisms
  - Individual-based stand models: distance-dependent and distance-independent
- Models at the landscape scale
  - Simple approaches: cellular automata
  - Dispersal and disturbances (windthrow, fire, bark beetles) as key mechanisms
- Landscape models
- Global models
  - Sacrificing local detail to attain global coverage: processes and entities
  - Dynamic Global Vegetation Models (DGVMs)
  - DGVMs as components of Earth System Models

Lecture notes
Handouts will be available in the course and for download

Literature
Will be indicated at the beginning of the course

Prerequisites / notice
- Basic training in modelling and systems analysis
- Good knowledge of general ecology, vegetation dynamics, and forest systems

701-1679-00L Spatial Modelling: From Climate & Land Use Change to Biodiversity Conservation

ECTS
5 credits
3U

Lecturers
L. Pellissier, N. Zimmermann

Objective
Students learn:
- Theoretical foundations of the species ecological niche
- Biodiversity concepts and global change impacts
- Basic concepts of spatial (and macro-) ecology
- Environmental impact assessment and planning
- Advanced statistical methods (GLM, GAM, CART) and basic programming (loops, functions, advanced scripting) in the statistical environment R
- The use of GIS functionality in R

Content
1. The basics:
- Introduction to the concept of the ecological niche, and biodiversity theories. Overview of the knowledge on expected biodiversity response to global changes and conservation planning methods.
- Introduction to the statistical methods of Generalized Linear (GLM) and Generalized Additive models (GAM), and Classification and Regression Trees (CART).
- Introduction to basic GIS and programming elements in the statistical environment R.

2. The class project:
- The use of GIS functionality in R
- Advanced statistical methods (GLM, GAM, CART) and basic programming (loops, functions, advanced scripting) in the statistical environment R.
- Environmental impact assessment and planning
- Advanced statistical methods (GLM, GAM, CART) and basic programming (loops, functions, advanced scripting) in the statistical environment R.
- Explaining and modelling land use change in Switzerland
- Explaining and modelling biodiversity changes in Switzerland
- Designing biodiversity conservation strategies under global changes.

Prerequisites / notice
Basic knowledge in statistics (OLS regression, test statistics), and basic knowledge in geographic information science.

Term Paper and Seminar

Number Title Type ECTS Hours Lecturers

Abstract
Individual writing of an essay-type review paper about a specialized topic in the field of ecology and evolution, based on substantial reading of original literature and discussions with a senior scientist.

Objective
- Students acquire a thorough knowledge on a topic in which they are particularly interested
- They learn to assess the relevance of original literature and synthesize information
- They make the experience of becoming "experts" on a topic and develop their own perspective
- They practise academic writing according to professional standards in English

Content
Topics for the essays are proposed by the professors and lecturers of the major in Ecology and Evolution at a joint meeting at the beginning of the semester (the date will be communicated by e-mail to registered students).

In all steps, they will benefit from the advice and detailed feedback given by a senior scientist acting as personal tutor of the student.

Electives

Number Title Type ECTS Hours Lecturers

Reading of articles in scientific journals

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1516 of 1571
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Semester</th>
<th>Credits</th>
<th>Offered</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td>701-0290-00L</td>
<td>Seminar in Microbial Evolution and Ecology</td>
<td>W</td>
<td>0</td>
<td>2S</td>
<td>S. Bonhoeffer</td>
</tr>
</tbody>
</table>

**Abstract**
Seminar of the groups Molecular Microbial Ecology, Theoretical Biology, Experimental Ecology, Evolutionary Biology. Talks given by members of these groups and external visitors.

**Objective**
In-depth introduction into microbial evolution and ecology, especially the aspects that are the focus of on-going research in this area at Department of Environmental Systems Science.

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<tbody>
<tr>
<td>701-1441-00L</td>
<td>Alpine Ecology and Environments</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>S. Dietz, D. Ramseier</td>
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</table>

**Abstract**
The online course ALPECOle provides a global overview of the complex ecosystems of mountain regions, and of their great diversity of habitats and organisms. The course is interdisciplinary and the various approaches are designed to help understand the past, present and future of mountain ecosystems.

**Objective**
Knowledge of alpine environments worldwide and their ecology

**Content**
The online course is subdivided into:
- 5 lessons on abiotic factors: geology, soils and their forming processes, climate, and disturbance factors
- 12 lessons on plants: diversity, patterns and processes, treelines, water & nutrients, carbon cycle, atmospheric influences, sexual and clonal reproduction, and one specific lesson on aquatric environments
- 5 lessons on animals: habitats and adaptations, origin of species, food ecology and impact of domestic livestock
- 3 lessons on landscape evolution: quaternary paleoenvironments, methods like radiocarbon dating, pollen records, dendrochronology, stable isotopes, and historical data
- 1 lesson on global change

Students can also follow a virtual walk through alpine areas where context-based information on alpine environments can be accessed. Moreover, all mayor alpine areas of the world can be selected on a map and then informative pictures of those landscapes and faunistic and floristic inhabitants will be shown.

**Prerequisites / notice**
Online course and seminar
Students prepare for the seminar by working through particular lessons. Each student has to present some special aspect of one lesson. The seminar contribution is part of the performance assessment.

Course language is English

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<th>Offered</th>
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<tr>
<td>551-0205-00L</td>
<td>Challenges in Plant Sciences</td>
<td>W</td>
<td>2</td>
<td>2K</td>
<td>W. Gruissem, C. Sánchez-Rodríguez, further lecturers</td>
</tr>
</tbody>
</table>

**Abstract**
The colloquium introduces students to the disciplines in plant sciences and provides integrated knowledge from the molecular level to ecosystems and from basic research to applications, making use of the synergies between the different research groups of the PSC. The colloquium offers a unique chance to approach interdisciplinary topics as a challenge in the field of plant sciences.

**Objective**
Major objectives of the colloquium are:
- introduction of graduate students and Master students to the broad field of plant sciences
- promotion of an interdisciplinary and integrative teaching program
- promotion of active participation and independent work of students
- promotion of presentation and discussion skills
- increased interaction among students and professors

**Content**
Challenges in Plant Sciences will cover the following topics:
- Chemical communication among plants, insect and pathogens.
- Specificity in hormone signaling.
- Genetic networks.
- Plant-plant interactions.
- Resilience of tropical ecosystems.
- Regulatory factors controlling cell wall formation.
- Chlorophyll breakdown.
- Innate immunity.
- Disease resistance genes.
- Sustainable agroecosystems.

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<th>Offered</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td>751-4504-00L</td>
<td>Plant Pathology I</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>B. McDonald</td>
</tr>
</tbody>
</table>

**Abstract**
Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems.

**Objective**
Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems as a basis for implementing disease management strategies in agroecosystems.
Course description: Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

Lecture Topics and Tentative Schedule

Week 1  No Lecture: First day of autumn semester

Week 2  The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nematode attack strategies and types of damage.


Week 5  Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.

Week 6  Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, preformed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.

Week 7  Pisatin and pisatin demethylase. Local and systemic acquired resistance, signal molecules.

Week 8  Pathogen effects on food quality and safety.

Week 9  Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics, including resistance, physiology, density, uniformity.

Week 10  Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.

Week 11  Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.

Week 12  Strategies for minimizing disease risks: principles of disease control and management.

Week 13  Disease control strategies: economic thresholds, physical control methods.

Week 14  Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

Lecture notes  Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.

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**Major in Human-Environment-Systems**

Students starting their Master programme in autumn semester 2016 or later cannot choose the Major Human-Environment Systems. Students who registered for the Major Human-Environment Systems autumn semester 2015 or before can finish this Major.

**Natural and Technological Systems**

**Environmental Assessment**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>102-0317-00L</td>
<td>Advanced Environmental Assessments</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Hellweg, R. Frischknecht</td>
</tr>
</tbody>
</table>

*Master students in Environmental Engineering choosing module Ecological Systems Design are not allowed to enrol 102-0317-00 Advanced Environmental Assessments (3KP) as already included in 102-0307-01 Advanced Environmental, Social and Economic Assessments (5KP).*

**Abstract**

This course deepens students' knowledge of the environmental assessment methodologies and their various applications.

**Objective**

This course has the aim of deepening students' knowledge of the environmental assessment methodologies and their various applications. In particular, students completing the course should have the

- Ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- Knowledge about the current state of the scientific discussion and new research developments
- Ability to properly plan, conduct and interpret environmental assessment studies
- Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers

**Content**

- Inventory developments, transparency, data quality, data completeness, and data exchange formats
- Allocation (multiooutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Recent development in impact assessment
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Uncertainty analysis
- Subjectivity in environmental assessments
- Multicriteria analysis
- Case Studies

**Lecture notes**

No script. Lecture slides and literature will be made available on the lecture homepage.

**Literature**

Literature will be made available on the lecture homepage.

**Prerequisites / notice**

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done classwork in this topic before are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. 2016: Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).
Foundations of Ecosystem Management, U. Bollens Hunziker

The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census
Basic literature and references are listed on the webpage.

Ecological Assessment and Evaluation

Type
Lecturers
Powerpoint slides are available on the webpage. Additional documents are handed out as copies.

Advanced Environmental Assessment (Computer Lab I)

Hours
Human Factors I

J. Ghazoul

ECTS
Lecturers
No Script

Prerequisites / notice
Prerequisite is enrolment of 102-0317-00 Advanced Environmental Assessments and of 102-0317-03 Advanced Environmental Assessments (Computer Lab I) in parallel or in advance (both courses in HS).

Landscape and Ecosystems

Number
Title
Type
ECTS
Hours
Lecturers
701-1453-00L
Ecological Assessment and Evaluation
W
3 credits
3G
F. Knaus, U. Bollens Hunziker

Abstract
The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

Objective
Students will be able to:
1) critically consider biological data books and local, regional, and national inventories;
2) evaluate the validity of ecological criteria used in decision making processes;
3) critically appraise the handling of ecological data and criteria used in the process of evaluation
4) perform an ecological evaluation project from the field survey up to the decision making and planning.

Lecture notes
The course structure changes between lecture parts, seminars and discussions. The didactic atmosphere is intended as working group.

Literature
Basic literature and references are listed on the webpage.

Prerequisites / notice
Prerequisites for attending this course are skills and knowledge equivalent to those taught in the following ETH courses:
- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbioökologie

701-1631-00L
Foundations of Ecosystem Management
W
5 credits
3G
J. Ghazoul, C. Garcia

Abstract
This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

Objective
Students should be able to
a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales,
b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.

Content
Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

Lecture notes
No Script

Literature

Social Systems (Micro, Macro)

Psychology

Number
Title
Type
ECTS
Hours
Lecturers
376-1177-00L
Human Factors I
W
2 credits
2V
M. Menozzi Jäckli, R. Huang, M. Siegrist
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

We will mostly work with readings from the following books:
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry, Digital Human Models
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students
- Further textbooks are introduced in the lecture
- Brouchures, checklists, key articles etc. are uploaded in ILIAS

### Political Sciences, Policy and Sociology

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
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<tr>
<td>701-1651-00L</td>
<td>Environmental Governance</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>E. Lieberherr, G. de Buren, R. Schweizer</td>
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</table>

**Abstract**

The course addresses environmental policies, focusing on new steering approaches, which are generally summarized as environmental governance. The course also provides students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

**Objective**

To understand how an environmental problem may (not) become a policy and explain political processes, using basic concepts and techniques from political science.

To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

**Content**

Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of ‘environmental governance’ and how legitimate and effective are these approaches in addressing persistent environmental challenges?

**Lecture notes**

Lecture slides and additional course material will be provided throughout the semester.

**Literature**

We will mostly work with readings from the following books:

**Prerequisites / notice**

A detailed course schedule will be made available at the beginning of the semester.

We recommend that students have (a) three-years BSc education of a (technical) university; (b) successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

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<td>851-0594-00L</td>
<td>International Environmental Politics</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>T. Bernauer</td>
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**Abstract**

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

**Objective**

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

**Content**

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory.
The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines. Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2017

The lecture is structured as follows:

- Overview of concepts and methods of inter/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)
The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It addresses the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

The course is seminar-like, interactive.

At the end of the course students should:

**Objective**

- Know:
  - core concepts of sustainable development, and;
  - the concept of social justice - normatively and empirically - as a core element of social sustainability;
  - important empirical methods for the analysis and assessment of local / regional sustainability issues.

- Understand and reflect on:
  - the challenges of trade-offs between the different goals of sustainable development;
  - and the respective impacts on individual and societal decision-making.

**Content**

The course is structured as follows:

- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;

- Trade-offs in selected examples.

**Prerequisites / notice**

This course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.

- **Number of participants limited to 30.**

**Literature**

Selected scientific articles and book-chapters


**Prerequisites / notice**

The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the sources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

**Lecture notes**

Handouts.

**Number**

701-1651-00L

**Type**

O

**ECTS**

3 credits

**Hours**

2G

**Lecturers**

E. Lieberherr, G. de Buren, R. Schweizer

**Course Title**

Environmental Governance

**Lecture notes**

Handouts provided by the lecturers.

**Literature**

Selected scientific articles and book-chapters

**Prerequisites / notice**

This course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.

**Number**

701-1551-00L

**Type**

W

**ECTS**

3

**Hours**

2G

**Lecturers**

P. Krütli, C. E. Pohl

**Course Title**

Sustainability Assessment

**Lecture notes**

Selected scientific articles & book-chapters

**Literature**


**Prerequisites / notice**

This course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.

**Number**

701-0727-00L

**Type**

W

**ECTS**

2

**Hours**

2G

**Lecturers**

U. Scheidegger

**Course Title**

Politics of Environmental Problem Solving in Developing Countries

**Lecture notes**

Selected scientific articles & book-chapters

**Literature**


**Prerequisites / notice**

This course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.

**Number**

701-1551-00L

**Type**

O

**ECTS**

3

**Hours**

2G

**Lecturers**

E. Lieberherr, G. de Buren, R. Schweizer
Abstract

The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and assesses the key features of environmental governance by examining various practical environmental policy examples. 

Objective

To understand how an environmental problem may (not) become a policy and explain political processes, using basic concepts and techniques from political science.

To analyze the evolution as well as the key elements of environmental governance.

Content

To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of 'environmental governance' and how legitimate and effective are these approaches in addressing persistent environmental challenges?

Lecture notes

Lecture slides and additional course material will be provided throughout the semester.

We will mostly work with readings from the following books:


Prerequisites / notice

A detailed course schedule will be made available at the beginning of the semester.

We recommend that students have (a) three-years BSc education of a (technical) university; (b) successfully completed Bachelor introduction course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy).

851-0585-41L Computational Social Science W 3 credits 2S D. Helbing, M. Leiss, O. C. Rouly

Abstract

The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and phenomena together with related empirical, experimental, and data-driven work. (2) combining perspectives of different scientific disciplines (e.g. sociology, computer science, physics, complexity science, engineering), (3) bridging between fundamental and applied work.

Objective

Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

They should also be able to explain how systemic instabilities can be understood by changing the perspective from a component-oriented to an interaction- and network-oriented view, and what fundamental implications this has for the proper design and management of complex dynamical systems.

Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

851-0589-00L Technology and Innovation for Development W 3 credits 2V P. Aerni

Abstract

Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects.

Objective

- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology

Content

Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies.

The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

Lecture notes

Reader with issue-specific articles. E-version is partly available under https://www.ethz.ch/content/specialinterest/gess/cs/international-relations/en/teaching/materials/tech.html


The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester.

Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.
Content
This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

Lecture notes
Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory.

Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <michaehu@student.ethz.ch>). All assigned papers must be read ahead of the respective meeting. Following the course on the basis of on-line slides and papers alone is not sufficient. Physical presence in the classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GESS library at the IFW building, Haldeneggsteig 4, B-floor, or in the library of D-USYS.

Literature
Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <michaehu@student.ethz.ch>).

Prerequisites / notice
None

851-0609-06L Governing the Energy Transition
Number of participants limited to 30.

W 2 credits 2V T. Schmidt
Primarily suited for Master and PhD level

Abstract
This course addresses the role of policy and its underlying politics in the transformation of the energy sector. It covers historical, socio-economic, and political perspectives and applies various theoretical concepts to specific aspects of governing the energy transition.

Objective
- To gain an overview of the history of the transition of large technical systems
- To recognize current challenges in the energy system to understand the theoretical frameworks and concepts for studying transitions
- To demonstrate knowledge on the role of policy and politics in energy transitions

Content
Climate change, access to energy and other societal challenges are directly linked to the way we use and create energy. Both the recent United Nations Paris climate change agreement and the UN Sustainable Development Goals make a fast and extensive transition of the energy system necessary. This course introduces the social and environmental challenges involved in the energy sector and discusses the implications of these challenges for the rate and direction of technical change in the energy sector. It compares the current situation with historical socio-technical transitions and derives the consequences for policy-making. It then introduces theoretical frameworks and concepts for studying innovation and transitions. It then focuses on the role of policy and policy change in governing the energy transition, considering the role of political actors, institutions and policy feedback.

The course has a highly interactive (seminar-like) character. Students are expected to actively engage in the weekly discussions and to give a presentation (15-20 minutes) on one of the weekly topics during that particular session. The presentation (30%) and participation in the discussions (20%) will form one part of the final grade, the remaining 50% of the final grade will be formed by a final exam.

Lecture notes
Slides and reading material will be made available via moodle.ethz.ch (only for registered students).

Literature
A reading list will be provided via moodle.ethz.ch at the beginning of the semester.

Prerequisites / notice
This course is particularly suited for students of the following programmes: MA Comparative International Studies; MSc Energy Science & Technology; MSc Environmental Sciences; MSc Management, Technology & Economics; MSc Science, Technology & Policy; ETH & UZH PhD programmes.

Modeling and Statistical Analysis

Number Title Type ECTS Hours Lecturers
701-1450-00L Ecological Assessment and Evaluation W 3 credits 3G F. Knaus, U. Bollens Hunziker

Abstract
The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

Objective
Students will be able to:
1) critically consider biological data books and local, regional, and national inventories;
2) evaluate the validity of ecological criteria used in decision making processes;
3) critically appraise the handling of ecological data and criteria used in the process of evaluation
4) perform an ecological evaluation project from the field survey up to the decision making and planning.

Lecture notes
Powerpoint slides are available on the webpage. Additional documents are handed out as copies.

Literature
Basic literature and references are listed on the webpage.

Prerequisites / notice
The course structure changes between lecture parts, seminars and discussions. The didactic atmosphere is intended as working group.

Prerequisites for attending this course are skills and knowledge equivalent to those taught in the following ETH courses:
- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbiodiversität

701-1541-00L Multivariate Methods

W 3 credits 2V+1U R. Hansmann

One of the lectures 701-1541-00 (autumn semester) OR 752-2110-00 (spring semester) are highly recommended for students in Environmental Sciences with the Major Environmental systems and Policy.

Abstract
The course teaches multivariate statistical methods such as linear regression, analysis of variance, cluster analysis, factor analysis and logistic regression.

Objective
Upon completion of this course, the student should have acquired:
1) Knowledge on the foundations of several methods of multivariate data analysis, along with the conditions under which their use is appropriate
2) Skill in the estimation, specification and diagnostics of the various models
3) Hands-on experience with those methods through the use of appropriate software and actual data sets in the PC lab

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1525 of 1571
The course will begin with an introduction to multivariate methods such as analysis of variance and multiple linear regression, where a metric dependent variable is "explained" by two or more independent variables. Then two methods for structuring complex data, cluster analysis and factor analysis will be covered. In the last part, procedures for the analysis of relationships involving dichotomous or polytomous dependent variables (e.g., the choice of a mode of transportation) will be discussed.

### Literature

Will be announced at the beginning of the course.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tr>
<td>860-0002-00L</td>
<td>Quantitative Policy Analysis and Modeling</td>
<td>6 credits</td>
<td>4G</td>
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<td></td>
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<td>A. Patt, T. Schmidt, E. Trutnevye, O. van Vliet</td>
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<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>3 credits</td>
<td>3G</td>
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<td></td>
<td></td>
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<td>F. Schweitzer, G. Casiraghi, V. Nanumyan</td>
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<tr>
<td>101-0491-00L</td>
<td>Agent Based Modeling in Transportation</td>
<td>W 3 credits</td>
<td>2G</td>
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<td>F. Ciari, M. Balac</td>
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</table>

### Abstract

**Systems Dynamics and Complexity**

The lectures will introduce students to the principles of quantitative policy analysis, namely the methods to predict and evaluate the social, economic, and environmental effects of alternative strategies to achieve public objectives. A series of graded assignments will give students an opportunity for students to apply those methods to a set of case studies.

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**Agent Based Modeling in Transportation**

The main topics of the course are:

1. Introduction to agent-based modeling and overview on existing agent-based models in transportation, including MATSim
2. Learn how to setup MATSim for policy analysis
3. Learn about the interfaces available to enhance the software (includes Java programming)
4. Create, run and analyse a policy study

The objective of this course is to make the students familiar with agent-based models and in particular with the software MATSim. They will learn the pros and cons of this type of approach versus traditional transport models and will learn to use the simulation. They will design a policy study and run simulations to evaluate the impacts of the proposed policies.

**Agent-based modeling in general**

- Additional relevant readings, mostly scientific articles, will be recommended throughout the course.

**Prerequisites / notice**

There are no strict preconditions in terms of which lectures the students should have previously attended. However, it is expected that the students have some experience with some high level programming language (i.e. C, C++, Fortran or Java). If this is not the case, attending the additional java exercises (101-0491-00U) is strongly encouraged.

---

**Content**

- **PART 1** introduces complexity as a system-immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

  - **PART 2** discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

  - **PART 3**, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamic and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

**Lecture notes**

- Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.
- Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

---

**Literature**

Agent-based modeling in general


MATSim


**Prerequisites / notice**

There are no strict preconditions in terms of which lectures the students should have previously attended. However, it is expected that the students have some experience with some high level programming language (i.e. C, C++, Fortran or Java). If this is not the case, attending the additional java exercises (101-0491-00U) is strongly encouraged.

---

**Abstract**

Finding solutions: what is complexity, problem solving cycle.

Implementing solutions: project management, critical path method, quality control feedback loop.

---

**Objective**

A successful participant of the course is able to:

1. **Introduction to agent-based paradigm and overview on existing agent-based models in transportation, including MATSim**
2. **Learn how to setup MATSim for policy analysis**
3. **Learn about the interfaces available to enhance the software (includes Java programming)**
4. **Create, run and analyse a policy study**

**Content**

Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:

1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system-immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

**Lecture notes**

- Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.
- Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

---

**Literature**

Agent-based modeling in general


MATSim


Additional relevant readings, mostly scientific articles, will be recommended throughout the course.

**Prerequisites / notice**

There are no strict preconditions in terms of which lectures the students should have previously attended. However, it is expected that the students have some experience with some high level programming language (i.e. C, C++, Fortran or Java). If this is not the case, attending the additional java exercises (101-0491-00U) is strongly encouraged.

---

**Abstract**

Finding solutions: what is complexity, problem solving cycle.

Implementing solutions: project management, critical path method, quality control feedback loop.

---

**Objective**

A successful participant of the course is able to:

1. **Introduction to agent-based paradigm and overview on existing agent-based models in transportation, including MATSim**
2. **Learn how to setup MATSim for policy analysis**
3. **Learn about the interfaces available to enhance the software (includes Java programming)**
4. **Create, run and analyse a policy study**

**Content**

Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:

1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system-immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

**Lecture notes**

- Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.
- Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

---

**Literature**

Agent-based modeling in general


MATSim


Additional relevant readings, mostly scientific articles, will be recommended throughout the course.

**Prerequisites / notice**

There are no strict preconditions in terms of which lectures the students should have previously attended. However, it is expected that the students have some experience with some high level programming language (i.e. C, C++, Fortran or Java). If this is not the case, attending the additional java exercises (101-0491-00U) is strongly encouraged.
The objectives of this course are to develop the following key skills necessary for policy analysts:

- Identifying the critical quantitative factors that are of importance to policy makers in a range of decision-making situations.
- Developing conceptual models of the types of processes and relationships governing these quantitative factors, including stock-flow dynamics, feedback loops, optimization, sources and effects of uncertainty, and agent coordination problems.
- Develop and program numerical models to simulate the processes and relationships, in order to identify policy problems and the effects of policy interventions.
- Communicate the findings from these simulations and associated analysis in a manner that makes transparent their theoretical foundation, the level and sources of uncertainty, and ultimately their applicability to the policy problem.

The course will proceed through a series of policy analysis and modeling exercises, involving real-world or hypothetical problems. The specific examples around which work will be done will concern the environment, energy, health, and natural hazards management.

### Policy Engagement

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1543-00L</td>
<td>Transdisciplinary Methods and Applications</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. Krütli, M. Stauffacher</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines. Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.</td>
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<tr>
<td>Objective</td>
<td>At the end of the course students should:</td>
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<td>Know:</td>
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<td>- Function, purpose and algorithm of a selected number of transdisciplinary methods</td>
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<td>Understand:</td>
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<td>- Functional application in case studies and other problem oriented projects</td>
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<td>Be able to reflect on:</td>
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<td>- Potential, limits, and necessity of transdisciplinary methods</td>
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<td>Be prepared for:</td>
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<td>- Transdisciplinary Case Study 2017</td>
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<td>Content</td>
<td>The lecture is structured as follows:</td>
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<td></td>
<td>- Overview of concepts and methods of inter-transdisciplinary integration of knowledge, values and interests (approx. 20%)</td>
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<td>- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)</td>
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<td>- Practical application of the methods in a broader project setting (approx. 30%)</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts are provided by the lecturers</td>
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<tr>
<td>Literature</td>
<td>Selected scientific articles and book-chapters</td>
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<tr>
<td>Prerequisites / notice</td>
<td>This course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.</td>
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<tr>
<td>701-1551-00L</td>
<td>Sustainability Assessment</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. Krütli, C. E. Pohl</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.</td>
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<td>Objective</td>
<td>The course is seminar-like, interactive.</td>
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<td>Know:</td>
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<td>- core concepts of sustainable development, and;</td>
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<td>- the concept of social justice - normatively and empirically - as a core element of social sustainability;</td>
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<td>- important empirical methods for the analysis and assessment of local / regional sustainability issues.</td>
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<td>Understand and reflect on:</td>
<td>- the challenges of trade-offs between the different goals of sustainable development;</td>
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<td>- and the respective impacts on individual and societal decision-making.</td>
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<td>Content</td>
<td>The course is structured as follows:</td>
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<td>- Overview of rationale, objectives, concepts and origins of sustainable development;</td>
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<td>- Importance and application of sustainability in science, politics, society, and economy;</td>
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<td>- Sustainable (local / regional) development in different national / international contexts;</td>
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<td>- Analysis and evaluation methods of sustainable development with a focus on social justice;</td>
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<td>- Trade-offs in selected examples.</td>
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<td>Lecture notes</td>
<td>Handouts.</td>
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<tr>
<td>Literature</td>
<td>Selected scientific articles &amp; book chapters</td>
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<tr>
<td>851-0735-11L</td>
<td>Environmental Regulation: Law and Policy</td>
<td>W</td>
<td>3</td>
<td>1S</td>
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<tr>
<td>Abstract</td>
<td>The course will be offered again in the spring semester 2017.</td>
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<tr>
<td>Objective</td>
<td>The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.</td>
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</table>
Content

Topics covered in lectures:

(1) Environmental Regulation
   a. Perspectives
   b. Regulatory Challenges of Environment Problems
   c. Regulatory Tools
(2) Law: International, European and national laws
   a. International law
   b. European law
   c. National law
(3) Policy: Case studies

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Lecture notes
The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Teaching will take place over two weeks in September and October. The exam date will be in December.

During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project.

Literature
An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

No specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0708-00 V) or an equivalent course.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

Major in Forest and Landscape Management

Natural Science Foundations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1613-01L</td>
<td>Advanced Landscape Research</td>
<td>W</td>
<td>5</td>
<td>3G</td>
<td>M. Bürgi, J. Bolliger, U. Gimmi, M. Hunziker</td>
</tr>
</tbody>
</table>

Abstract
This course introduces landscapes as socially perceived, spatially and temporally dynamic entities that are shaped by natural and societal factors. Concepts and qualitative and quantitative methods to study landscapes from an ecological, societal and historical perspective are presented. In a term paper students work on a landscape-related topic of their choice.

Objective
Students will:
- learn about concepts and methods to quantify structural and functional connectivity in landscapes, particularly
- be introduced to the topic of landscape genetics and its benefits and (current) limitations for applied conservation
- learn about concepts and methods in scenario-based land-use change modelling
- approach an understanding of landscape as perceived environment
- understand the role of landscape for human well-being
- be introduced into approaches of actively influencing attitudes and behavior as well as related scientific evaluation
- make use of various historical sources to study landscapes and their dynamics
- interpret landscapes as a result of ecological constraints and anthropogenic activities.

Content
1. Encompassing concepts and approaches
   - European Landscape Convention (ELC)
   - Ecosystem Services (ES): introduction and critical evaluation

Thematic topics
2. Ecological approach:
   - green infrastructure (e.g., ecological conservation areas)
   - landscape connectivity
   - landscape genetics and management applications
   - concepts of specific quantitative methods: least cost paths, resistance surfaces, Circuitscape, networks (Conefor), land-use change models, various statistical methods

3. Social-science approach:
   - principle of landscape as perceived and connoted environment
   - theories on landscape preference and place identity
   - role of landscapes for recreation, health and well-being
   - intervention approaches for influencing attitudes and related behavior
   - methods of investigating the human-landscape relationship and evaluating interventions

4. Historical approach:
   - land use history of Switzerland (agricultural history, forest and woodland history)
   - historical legacies of land use in landscapes and ecosystems
   - historic-ecological approaches and applications

5. Land change science:
   - modelling future land-use (CLUE, other scenario-based models)
   - landscape functions and services

Lecture notes
Handouts will be available in the course and for download

Prerequisites / notice
Basic Landscape Ecology courses at Bachelor level
Advanced Forest Pathology

Abstract: In-depth understanding of concepts, insight into current research and experience with methods of Forest Pathology based on selected pathosystems.

Objective: To know current biological and ecological research on selected diseases, to be able to comment on it and to understand the methods.

Content: To understand the dynamics of selected pathosystems and disturbance processes.

Prerequisites / notice: Systems (examples): Air pollution and trees, endophytic fungi, mycorrhiza, wood decay, conifer- root rot, Phytophthora diseases, chestnut canker and its hypoviruses, urban trees, complex diseases, emerging diseases

Lecture notes: no script, the ppt-presentations and specific articles will be made available


Lecture notes: 701-1515-00L

Handouts will be available as they are developed.

Mountain Forest Hydrology

Abstract: This course presents a process-based view of the hydrology, biogeochemistry, and geomorphology of mountain streams. Students learn how to integrate process knowledge, data, and models to understand how landscapes regulate the fluxes of water, sediment, nutrients, and pollutants in streams, and to anticipate how streams will respond to changes in land use, atmospheric deposition, and climate.

Objective: They will practice using data and models to frame and test hypotheses about connections between streams and landscapes.

Content: Streams are integrated monitors of the health and functioning of their surrounding landscapes. Streams integrate the fluxes of water, solutes, and sediment from their contributing catchment area; thus they reflect the spatially integrated hydrological, ecophysiological, and geomorphological processes in the surrounding landscape. At a practical level, there is a significant public interest in managing forested upland landscapes to provide a reliable supply of high-quality surface water and to minimize the risk of catastrophic flooding and debris flows, but the scientific background for such management advice is still evolving.

Using a combination of lectures, field exercises, and data analysis, we explore the processes controlling the delivery of water, solutes, and sediment to streams, and how those processes are affected by changes in land cover, land use, and climate. We review the connections between process understanding and predictive modeling in these complex environmental systems. How well can we understand the processes controlling watershed-scale phenomena, and what uncertainties are unavoidable? What are the relative advantages of top-down versus bottom-up approaches? How much can “black box” analyses reveal about what is happening inside the black box?

Conversely, can small-scale, micro-mechanistic approaches be successfully “scaled up” to predict whole-watershed behavior? Practical problems to be considered include the effects of land use, atmospheric deposition, and climate on streamflow, water quality, and sediment dynamics, illustrated with data from experimental watersheds in North America, Scandinavia, and Europe.

Lecture notes: Handouts will be available as they are developed.

Literature: Recommended and required reading will be specified at the first class session (with possible modifications as the semester proceeds).

701-1613-00L

Foundations of Ecosystem Management

Abstract: This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

Objective: a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales;

b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.

Content: Traditionally, management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscapes ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

Lecture notes: No Script


Multifunctional Forest Management

Abstract: Multifunctional forest management needs to control natural processes such that they efficiently provide the diverse services and goods for society in a sustainable and close to nature way. This course provides the the basic knowledge, the principles and the management tools for successful multifunctional forest management.
Objective

Forests in heavily populated areas need to provide diverse ecosystem services and goods for the benefits of society. Multifunctional forest management thus needs to control natural processes such that they efficiently provide these services and goods in a sustainable and close to nature way. This course provides the knowledge, the principles and the management tools for multifunctional forest management. Different strategies and management options are presented and discussed.

Content

Identification of social needs for the multi-dimensional ecosystem goods and services and their transformation into detailed objectives (profiles) regarding ecosystem functions, structures and processes.

Understanding of the important natural processes and their spatial and temporal dynamics in the most important forest ecosystems of Europe.

Identification of critical, relevant processes and ecosystem conditions for the different objectives (profiles).

Development of management options and strategies and assessment of their effects on ecosystem goods and services.

Lecture notes

No class notes or text books

Lecture presentations are available for download

Reading assignments are given in class

A bibliography of cited literature will be available

Prerequisites / notice

Course language is German. Prerequisites: Sufficient German language skills.

In addition to the lectures students need to attend 4 all day field excursions. Topic: Near natural and efficient tending concepts. Participating on all 4 field trips is a prerequisite for credits.

Additional field excursions focusing on the Swiss fellschlag system, the Plenter- and other irregular systems will be offered during spring term in an optional course named "AK des multifunktionalen Waldmanagements". 9 days of field trips will provide the possibility to consolidate theoretical knowledge, to apply it to real examples in the field, to discuss and further consolidate what has been taught in this class. The additional course is an important part of the overall formation on forest management and is highly recommended.

Decision Making, Policy and Planning

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0743-01L</td>
<td>Law and Natural Resources</td>
<td>W</td>
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<td>The course will be offered again in the spring semester 2017.</td>
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<tr>
<td>Abstract</td>
<td>This course teaches the possibilities and limits of the law in order to protect natural resources and landscapes against harm and nuisance. The learning concept is based on the co-ordinated implementation of the relevant legislations. The complexity of the legal situation will be discussed by analysing virtual and real law cases focused on spatial projects and planning.</td>
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<tr>
<td>Objective</td>
<td>The students know the opportunities and restrictions which are given by the law when using natural resources. They have insights into the complex environmental legal system and their application in concrete cases. The students are able to formulate typical legal questions, to understand the argumentation of courts and to solve simple legal problems with respect to environmental problems.</td>
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<tr>
<td>Lecture notes</td>
<td>Den Studierenden werden Unterlagen wie eine Übersicht über den behandelten Stoff auf PP-Folien, typische Gerichtsentscheide, Zeitungsartikel etc. über neue Vorhaben mit Auswirkungen auf die Umwelt und entsprechenden Rechtsfragen abgegeben.</td>
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<tr>
<td>Literature</td>
<td>Griffel, A.; Raumplanungs- und Baurecht in a nutshell, Dike Verlag, Zürich/St. Gallen 2012</td>
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<td></td>
<td>Rausch/Marti/Griffel; Umweltrecht Ein Lehrbuch. Herausgeber: Walter Haller. Schullthess Verlag, Zürich 2004</td>
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<td>Rausch, H.; Panorama des Umweltrechts - Kompendium der Umweltzuschütevorschriften des Bundes, BUWAL-Schriftenreihe Umwelt Nr. 226, 4. A., Bern 2005</td>
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<td>Keel/Zimmermann; Bundesgerichtliche Rechtsprechung zur Waldgesetzgebung. In URP 2009/3</td>
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<td>Umweltrecht in der Praxis URP (Juristische Fachzeitschrift für Umweltrecht und -gesetze, herausgegeben von der Vereinigung für Umweltrecht (VUR)</td>
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<td>Weitere Literaturangaben erfolgen in der ersten Veranstaltung.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Die Veranstaltung ist eine vorwiegend mit konkreten Beispielen arbeitende und auf natürliche Ressourcen, Landschaften und Raumordnung fokussierte Vertiefung. Die Studierenden können eigene &quot;Fälle&quot; aus dem persönlichen Umfeld einbringen. Der Besuch des Kurses &quot;Umweltrecht: Konzepte und Rechtsgebiete&quot; (851-0705-01) wird empfohlen.</td>
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Environmental Governance

Number of participants limited to 30.

The course addresses environmental policies, focusing on new steering approaches, which are generally summarized as environmental governance. The course also provides students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

Objective

To understand how an environmental problem may (not) become a policy and explain political processes, using basic concepts and techniques from political science.

To analyze the evolution as well as the key elements of environmental governance.

To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

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Content

Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of ‘environmental governance’ and how legitimate and effective are these approaches in addressing persistent environmental challenges?

Lecture notes

Lecture slides and additional course material will be provided throughout the semester.

Literature

We will mostly work with readings from the following books:

Prerequisites / notice

A detailed course schedule will be made available at the beginning of the semester.

We recommend that students have (a) three-years BSc education of a (technical) university; (b) successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

Methods and Tools

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>701-1673-00L</td>
<td>Environmental Measurement Laboratory</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>P. U. Lehmann Grunder, D. Or</td>
</tr>
<tr>
<td>Abstract</td>
<td>Measurements are the sole judge of scientific truth and provide access to unpredictable information, enabling the characterization and monitoring of complex terrestrial systems. Based on lectures and field- and laboratory training the students learn to apply modern methods to determine forest inventory parameters and to measure subsurface properties and processes.</td>
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</table>
| Objective | - explain functioning of sensors that are used for characterization of landscapes and terrestrial systems  
- select appropriate measurement methods and sampling design to quantify key variables and processes in the subsurface  
- deploy sensors in the field and maintain sensor network  
- interpret collected laboratory and field data and report main conclusions deduced from measurements |
| Content  | 1) Measurement Science: Measurement precision and accuracy; sensing footprint, sampling design and sampling errors, uncertainty reduction, spatial and temporal variability, sampling network design and information costs |
|          | 2) Electronics: Basic introduction to electronic components, voltage and current measurements, A/D converters, power requirements, power consumption calculations, batteries, storage capacity, solar panels |
|          | 3) Datalogging (Lecture): Data Logging, data transfer, storage, and sensing technologies; basic data logger programming; overview of soil sensor types and sensor calibration; including programming in the laboratory |
|          | 4) Geophysical methods on Subsurface Characterization: Basic principles of ERT, GPR, and EM; |
|          | 5) Soil and Groundwater Direct Sampling (Lab): Soil physical sampling; profile characterization, disturbed and undisturbed soil sampling, direct-push geoprobe sampling; soil water content profiles and transects; |
|          | 6) Electronics Laboratory: Setup and measurement of simple circuits, selection and use of voltage dividers, batteries and solar panels; pressure and temperature measurements; |
|          | 7) Deployment of monitoring network: Field installation of TDR, temperature probes, tensiometers, data loggers and power supply |
|          | 8) Geophysics lab: Demonstration and application of geophysical methods in the field; |
|          | 9 & 10) Forest characterization/inventory: Principles of LIDAR; structures and features of the tree crowns, size/volume of the leaf area tree positions and diameters at breast height |
|          | 11&12) Ecological and Soil Monitoring Networks- Data management for long term monitoring networks Tereno, and other critical zone observatories |

Lecture notes

Lecture material on page

Literature

Lecture material will be online for registered students: http://www.step.ethz.ch/education/environmental-measurement-lab.html

Prerequisites / notice

The details of the schedule will be optimized based on the number of students; some blocks of the course will be offered as well to students of Environmental Engineering

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>701-1679-00L</td>
<td>Spatial Modelling: From Climate &amp; Land Use Change to Biodiversity Conservation</td>
<td>W</td>
<td>5</td>
<td>3U</td>
<td>L. Pellissier, N. Zimmermann</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides the student with the spatial tools to address societal challenges toward ensuring the sustainable use of terrestrial ecosystems and the conservation of biodiversity. Students learn theory, tools and models during a few introductory sessions and apply this knowledge to solve a practical problem in groups related to climate change, land use change and biodiversity conservation.</td>
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</table>
| Objective | Students learn:  
- Theoretical foundations of the species ecological niche  
- Biodiversity concepts and global change impacts  
- Basic concepts of spatial (and macro-) ecology  
- Environmental impact assessment and planning  
- Advanced statistical methods (GLM, GAM, CART) and basic programming (loops, functions, advanced scripting) in the statistical environment R.  
- The use of GIS functionality in R |

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Conservation and Development in Complex Landscapes

The field course in Belize will develop an understanding of, and solutions to, issues of landscape management relevant to conservation and management of tropical forest systems. Designed as a complementary course to Rain Forest Ecology 701-0324-00L. Students will gain first-hand experience of tropical forest landscapes and the challenges associated with conducting ecological research in this fascinating environment.

Day 1: Ecology of the forest habitats
A first impression of the biology of the region will be gained through an exploration of the different forest formations, ranging from mesic forests to dry evergreen, dry deciduous, and mangrove forests. The learning objective will be to understand the underlying environmental conditions that determine forest formations within the relatively small area of Shipstern Reserve. This includes linking climate, soil, and geology with community processes to understand the mosaic of habitat types, their distribution, form, and function.

Day 2: The ecology of natural resources
Students will begin to explore how people use forest resources, ranging from timber, to a variety of non-timber forest products, and animals for hunting. This will lead to an evaluation of threats to species and habitats, and hence set the scene for subsequent work.

Day 3: Familiarisation with landscape scale dynamics
We will explore the land uses in the landscape in the vicinity of Shipstern and Freshwater creeks. This will encompass a range of land uses, including small scale to large scale agriculture, extractive forest reserves, and protected forests. In the process the students will gain a better understanding of the pressures on land and forests, and a chance to meet some of the local stakeholders involved in land use transformations.

Days 4 & 5: Problem conceptualisation
Working with reserve managers and local stakeholders the students will develop a conceptual understanding of the key problems in the region, including the underlying drivers of change.

Days 6-9: Integrative analysis
Students, working in small groups, will analyse selected natural resource problems in greater depth. Options include biodiversity responses to habitat fragmentation, conservation management of mangrove and coral reef systems, restoration ecology, community forest management, and tourism development, among others. Students will have opportunities to collect original data across natural and social sciences, and will use different modelling approaches to explore future development trajectories.

Day 10-11: Synthesis and presentation of results
Research will be synthesised and presented to the local management community of Shipstern and Freshwater Creek reserves. The course will conclude with an afternoon allocated to discussion and debriefing, including an appraisal of the challenges of addressing natural resource management issues in complex socioecological systems, and the lessons learned.

Prerequisites / notice
Basic knowledge in statistics (OLS regression, test statistics), and basic knowledge in geographic information science.

Ecosystem Management

1. The basics:
   - Introduction to the concept of the ecological niche, and biodiversity theories. Overview of the knowledge on expected biodiversity response to global changes and conservation planning methods.
   - Introduction to the statistical methods of Generalized Linear (GLM) and Generalized Additive models (GAM), and Classification and Regression Trees (CART). Introduction to basic GIS and programming elements in the statistical environment R.

2. The class project:
   - Students form groups of two, and each group solves a series of applied questions independently in R using the techniques taught in the introductory classes. The students then prepare a presentation and report of the obtained results that will be discussed during a mini-symposium. Each team choses one of the following topics for the class project:
     a) Linking climate change velocities to species' migration capacities
     b) Explaining and modellind land use change in Switzerland
     c) Explaining and modellind biodiversity changes in Switzerland
     d) Designing biodiversity conservation strategies under global changes.

Prerequisites / notice
Basic knowledge in statistics (OLS regression, test statistics), and basic knowledge in geographic information science.

Electives

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>701-1453-00L</td>
<td>Ecological Assessment and Evaluation</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>F. Knaus, U. Bollens Hunziker</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.</td>
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<td>Objective</td>
<td>Students will be able to:</td>
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<tr>
<td></td>
<td>1) critically consider biological data books and local, regional, and national inventories;</td>
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<td>2) evaluate the validity of ecological criteria used in decision making processes;</td>
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<td>3) critically appraise the handling of ecological data and criteria used in the process of evaluation</td>
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<td>4) perform an ecological evaluation project from the field ecology to the decision making and planning.</td>
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<tr>
<td>Literature</td>
<td>Powerpoint slides are available on the webpage. Additional documents are handed out as copies.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Basic literature and references are listed on the webpage.</td>
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<tbody>
<tr>
<td>701-1661-00L</td>
<td>Conservation and Development in Complex Landscapes</td>
<td>W</td>
<td>3</td>
<td>6G</td>
<td>J. Ghazoul</td>
</tr>
<tr>
<td>Abstract</td>
<td>The field course in Belize will develop an understanding of, and solutions to, issues of landscape management relevant to conservation and natural resources. Students will be expected to integrate skills in quantitative natural science with social science approaches in real world, and hence highly complex, settings.</td>
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<td>Objective</td>
<td>To address complex multi-dimensional environmental problems through the application of interdisciplinary and transdisciplinary skills.</td>
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<td>Content</td>
<td>Day 1: Ecology of the forest habitats</td>
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<td>A first impression of the biology of the region will be gained through an exploration of the different forest formations, ranging from mesic forests to dry evergreen, dry deciduous, and mangrove forests. The learning objective will be to understand the underlying environmental conditions that determine forest formations within the relatively small area of Shipstern Reserve. This includes linking climate, soil, and geology with community processes to understand the mosaic of habitat types, their distribution, form, and function.</td>
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<td>Day 2: The ecology of natural resources</td>
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<td>Students will begin to explore how people use forest resources, ranging from timber, to a variety of non-timber forest products, and animals for hunting. This will lead to an evaluation of threats to species and habitats, and hence set the scene for subsequent work.</td>
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<td>Day 3: Familiarisation with landscape scale dynamics</td>
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<td>We will explore the land uses in the landscape in the vicinity of Shipstern and Freshwater creeks. This will encompass a range of land uses, including small scale to large scale agriculture, extractive forest reserves, and protected forests. In the process the students will gain a better understanding of the pressures on land and forests, and a chance to meet some of the local stakeholders involved in land use transformations.</td>
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<td>Working with reserve managers and local stakeholders the students will develop a conceptual understanding of the key problems in the region, including the underlying drivers of change.</td>
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<td>Days 6-9: Integrative analysis</td>
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<td>Students, working in small groups, will analyse selected natural resource problems in greater depth. Options include biodiversity responses to habitat fragmentation, conservation management of mangrove and coral reef systems, restoration ecology, community forest management, and tourism development, among others. Students will have opportunities to collect original data across natural and social sciences, and will use different modelling approaches to explore future development trajectories.</td>
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<td>Research will be synthesised and presented to the local management community of Shipstern and Freshwater Creek reserves. The course will conclude with an afternoon allocated to discussion and debriefing, including an appraisal of the challenges of addressing natural resource management issues in complex socioecological systems, and the lessons learned.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Foundations of Ecosystem Management</td>
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<tr>
<td>701-1663-00L</td>
<td>Exploring Resilience of Tropical Forest Landscapes</td>
<td>W</td>
<td>4</td>
<td>9G</td>
<td>C. Kettle, C. D. Phillipson</td>
</tr>
<tr>
<td>Abstract</td>
<td>A highly interactive learning experience with real world exposure to the challenges associated with conservation and management of tropical forest systems. Designed as a complementary course to Rain Forest Ecology 701-0324-00L. Students will gain first-hand experience of tropical forest landscapes and the challenges associated with conducting ecological research in this fascinating environment.</td>
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701-1453-00L
Ecological Assessment and Evaluation
W
3 credits
3G
F. Knaus, U. Bollens Hunziker

701-1661-00L
Conservation and Development in Complex Landscapes
W
3 credits
6G
J. Ghazoul

701-1663-00L
Exploring Resilience of Tropical Forest Landscapes
W
4 credits
9G
C. Kettle, C. D. Phillipson

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Objective
The course will have four core learning objectives: 1) provide students with an understanding and experience of a range of tropical rainforest systems, and an appreciation of the challenges of managing these landscapes to provide multiple ecosystem services. 2) To develop their creative and critical scientific thinking and experimental design in the context of tropical field ecology. Specifically through design and implementation an Adaptive Management approach to tropical forest landscapes. 3) Students will develop their understanding of multiple stakeholders perspectives in the context of landscape management in SE Asian develop the knowledge to discuss this issues with experts in the field. Students will present their Adaptive Management Plans to senior Forest Researchers in the forest department at the FRC Sabah and engage in dialogue regarding diverse perspectives in forest and landscape management. 4) To develop their team building skills to work in culturally diverse groups and under sometimes challenging conditions to work toward a common research goal.

Content
Proposed topics to be covered within the scope of the projects and based upon the expertise of the course lecturers: Tropical Ecology, Forest Ecology and Forest Botany. Tropical Forest management and restoration. Conservation biology, Animal behaviour, tropical entomology, Biodiversity and ecosystem function, Resilience and Adaptive Management.

Literature
Literature presented in Tropical Rainforest Ecology

Prerequisites / notice
701-0324-00 G Rain Forest Ecology

>>> Decision Making, Policy and Planning

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>851-0735-11L</td>
<td>Environmental Regulation: Law and Policy</td>
<td>W</td>
<td>3 credits</td>
<td>1S</td>
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</table>

Number of participants limited to 15.

Abstract
The aim of this course is to make students with a technical scientific background aware of the legal and political context of environmental policy in order to place technical solutions in their regulatory context.

Objective
The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.

Content
Topics covered in lectures:

1. Environmental Regulation
   a. Perspectives
   b. Regulatory Challenges of Environment Problems
   c. Regulatory Tools
2. Law: International, European and national laws
   a. International law
   b. European law
   c. National law
3. Policy: Case studies

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Lecture notes
The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project. During the exam period, students will have individual meetings with the lecturer to discuss their project.

Literature
An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

Prerequisites / notice
No specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0708-00 V) or an equivalent course.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

>>> Methods and Tools

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<tr>
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<tbody>
<tr>
<td>701-1316-00L</td>
<td>Physical Transport Processes in the Natural Environment</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>J. W. Kirchner</td>
</tr>
</tbody>
</table>

Abstract
Fluid flows transport all manner of biologically important gases, nutrients, toxins, contaminants, spores and seeds, as well as a wide range of organisms themselves. This course explores the physics of fluids in the natural environment, with emphasis on the transport, dispersion, and mixing of solutes and entrained particles, and their implications for biological and biogeochemical processes.

Objective
Students will learn key concepts of fluid mechanics and how to apply them to environmental problems. Weekly exercises based on real-world data will develop core skills in analysis, interpretation, and problem-solving.

Content
dimensional analysis, similarity, and scaling
solute transport in laminar and turbulent flows
transport and dispersion in porous media
transport of sediment (and adsorbed contaminants) by air and water
anomalous dispersion

Lecture notes
The course is under development. Lecture materials will be distributed as they become available.

701-1671-00L Sampling Techniques for Forest Inventories | W    | 3 credits | 2V    | D. Mandallaz |

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Abstract
Introduction to design and model assisted sampling theory for finite populations as well as to the infinite population model for forest inventory. Two-phase two-stage forest inventories with simple or cluster sampling. Small area estimation. Presentation of the Swiss National Inventory.

Short introduction to Kriging techniques.

Objective
Students should have a good understanding of the concepts of general sampling theory in a modern framework. They should also master the specific problems arising in forest inventory and be able, if necessary, to read more specialized books or research papers.

Content

Lecture notes
Sampling techniques for forest inventories. Daniel Mandallaz, Chapman and Hall. A free electronic copy of the book is also available. A PDF file containing parts of the book will be mailed to the participants.

Literature

Prerequisites / notice
A simulation software will be used throughout the lectures to illustrate the theoretical developments. Upon request a half day field demonstration can be organized at the WSL outside the lecture time. A repetitorium for the exam is also offered.

701-1677-00L Quantitative Vegetation Dynamics: Models from Tree to Globe

Abstract
This course provides hands-on experience with models of vegetation dynamics across temporal and spatial scales. The underlying principles, assets and trade-offs of the different approaches are introduced, and students work in a number of small projects with these models to gain first-hand experience.

Objective
Students will
- be able to understand, assess and evaluate the fundamental properties of dynamic systems using vegetation models as case studies
- obtain an overview of dynamic modelling techniques from the individual plant to the global level
- understand the basic assumptions of the various model types, which dictate the skill and limitations of the respective model
- be able to work with such model types on their own
- appreciate the methodological basis for impact assessments of future climate change and other environmental changes on ecosystems.

Content
Models of individuals
- Deriving single-plant models from inventory measurements
- Plant models based on 'first principles'

Models at the stand scale
- Simple approaches: matrix models
- Competition for light and other resources as central mechanisms
- Individual-based stand models: distance-dependent and distance-independent

Models at the landscape scale
- Simple approaches: cellular automata
- Dispersal and disturbances (windthrow, fire, bark beetles) as key mechanisms
- Landscape models

Global models
- Sacrificing local detail to attain global coverage: processes and entities
- Dynamic Global Vegetation Models (DGVMs)
- DGVMs as components of Earth System Models

Lecture notes
Handouts will be available in the course and for download

Literature
Will be indicated at the beginning of the course

Prerequisites / notice
- Basic training in modelling and systems analysis
- Good knowledge of general ecology, vegetation dynamics, and forest systems

701-1682-00L Dendroecology

Abstract
The course dendroecology offers theoretical and practical aspects of dendrochronology. The impact of different environmental influences on tree-ring characteristics will be shown. The students learn various methods to date tree rings and they understand how ecological and environmental processes and patterns can be reconstructed using tree rings.

Objective
The students...
- understand, how wood is configured and how tree-ring structures are formed.
- are able to identify and describe different tree-ring structures.
- understand the theoretical and practical aspects of the dating of tree rings.
- know the effects of different abiotic and biotic environmental influences (climate, site, competition, insects, fire, physical-mechanical influences) on trees and tree rings.
- discover a tool for understanding and reconstructing global change processes.
- learn software to date, standardize and analyze tree rings.
- get hands-on experience based on the demonstration of wood (increment cores, stem discs, wedges), sampling in the field, and measuring and dating of tree rings in the tree-ring lab.
- solve R-based exercises (R tutorial will be provided) and answer questions in Moodle.
- work out an independent research question related to a dendroecological topic and write a short literature review based on scientific papers.
Content
- Overview and history of dendrochronology
- Principles of dendrochronology
- Evolution of tree rings
- Formation and structure of wood and tree rings
- Intra-seasonal tree-ring growth
- Continuous and discontinuous tree-ring characteristics
- Sampling and measuring
- Crossdating methods (visual, skeleton plots, quantitative)
- Standardization of tree-ring series
- Development of tree-ring chronologies
- Dendrogeomorphology, dendrohydrology, dendroglaciology
- Stable isotopes
- Climate, climate-growth relationships, climate reconstructions
- Age and size structures, forest dynamics (regeneration, growth, competition, mortality)
- Disturbance ecology (fire, insects, blowdown)
- Application of tree-ring research in practice and in interdisciplinary research projects
- Field and lab day (date for one entire day or two half days will be searched together with the students in the beginning of the semester):
  - discussion of different dendroecological questions in the forest; sampling of trees; insight into different tree-ring projects in the lab (Swiss Federal Institute for Forest, Snow and Landscape Research WSL)

Lecture notes
Lecture notes (in English) will be handed out in the class.

The course communicates the basics of the programming language Python and gives a general introduction into the geoprocessing frameworks arcpy and covers basic language concepts of Python such as datatypes, control structures and functions. In addition the application of popular Python libraries in combination with spatial datasets will be shown.

Time schedule (total of 90 hours):
- There will be 12 lectures with each two hours (total of 24 hours presence) as well as a field and lab day (8 hours presence). In addition, the students are expected to put 18 hours into the preparation of the lectures as well as 18 hours for the exercises. 4 hours are reserved for the lab work and 18 hours for the project.

The class language is German and English, on request English only.

Requirements:
- Basics of biology, ecology and forest ecology

Prerequisites / notice

701-1776-00L Geographic Data Processing with Python and ArcGIS
- 1 credit
- 2U
- A. Baltensweiler

Abstract
The course communicates the basics of the programming language Python and gives a general introduction into the geoprocessing frameworks arcpy and ArcGIS. In addition various Python libraries (numpy, Scipy, GDAL, statsmodels, pandas) will be introduced which increase the functional range of the geoprocessing framework substantially.

Objective
The students learn the basics of geographic data processing based on the programming language Python and ArcGIS (arcpy). They get the ability to implement their own processes and models for geoprocessing. The students are able to integrate open source libraries such as ArcPy into their python scripts and know how the libraries are applied to spatial datasets.

Content
The course communicates a deepened understanding of the geoprocessing frameworks arcpy and covers basic language concepts of Python such as datatypes, control structures and functions. In addition the application of popular Python libraries in combination with spatial datasets will be shown.

Literature

Prerequisites / notice
The course will be taught in German. All material will be provided in English. Knowledge of ArcGIS is assumed.

401-0627-00L Smoothing and Nonparametric Regression with Python Examples
- 4 credits
- 2G
- S. Beran-Ghosh

Abstract
Starting with an overview of selected results from parametric inference, kernel smoothing (including local polynomials) will be introduced along with some asymptotic theory, optimal bandwidth selection, data driven algorithms and some special topics. Examples from environmental research will be used for motivation, but the methods will also be applicable elsewhere.

Objective
The students will learn about methods of kernel smoothing and application of concepts to data. The aim will be to build sufficient interest in the topic and intuition as well as the ability to implement the methods to various different datasets.

Content
Rough Outline:
- Parametric estimation methods: selection of important results
  - Maximum likelihood
- Least squares: regression & diagnostics
- Nonparametric curve estimation
  - Density estimation, Kernel regression, Local polynomials, Bandwidth selection
  - Selection of special topics (as time permits, we will cover as many topics as possible) such as rapid change points, mode estimation, robust smoothing, partial linear models, etc.
- Applications: potential areas of applications will be discussed such as, change assessment, trend and surface estimation, probability and quantile curve estimation, and others.

Lecture notes
Brief summaries or outlines of some of the lecture material will be posted at http://www.wsl.ch/info/mitarbeitende/ghosh/index_EN (click on "ETH Course" in the left panel).

NOTE: The posted notes will tend to be just sketches whereas only the in-class lessons will contain complete information.

LOG IN: In order to have access to the posted notes, you will need the course user id & the password. These will be given out on the first day of the lectures.

Additional references will be given out in the lectures.

**References:**

- S.D. Silvey, Chapman & Hall.
- J. Fan and I. Gijbels, Chapman & Hall.
- J. Fox, Sage Publications.
- A.W. Bowman, A. Azzalini, Oxford University Press.

**Prerequisites / notice**

Prerequisites: A background in Linear Algebra, Calculus, Probability & Statistical Inference including Estimation and Testing.

## Colloquium

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1691-00L</td>
<td>Colloquium Forest and Landscape Management</td>
<td>Z</td>
<td>0</td>
<td>1.5K</td>
<td>H. Bugmann</td>
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</table>

**Objective**

This course is geared towards outreach and dissemination of research results to Swiss forest practitioners. As a rule, it is run in German, in some cases in French, and as an exception in English.

**Literature**

wird angegeben, so weit sinnvoll

## Major in Human Health, Nutrition and Environment

### Public Health

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<tr>
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<tbody>
<tr>
<td>401-0629-00L</td>
<td>Applied Biostatistics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Müller</td>
</tr>
</tbody>
</table>

**Abstract**

Principles and main methods in biostatistics with emphasis on practical aspects. Experimental and observational studies. Regression and analysis of variance. Introduction into survival analysis.

**Objective**

Getting an overview of the problems and statistical methods used in health sciences. Practise in using the software R to analyze data and interpreting the suits.

**Content**


**Literature**


### Epidemology and Prevention

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<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>752-6105-00L</td>
<td>Epidemiology and Prevention</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. Puhan, R. Heusser</td>
</tr>
</tbody>
</table>

**Abstract**

Enrolment to this course unit only possible at ETH. No enrolment to module CS16_101 at UZH.

Please mind the ETH enrolment deadlines for UZH students: https://www.ethz.ch/en/studies/non-degree-courses/special-students-university-of-zurich.html

**Objective**

The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.

**Content**

The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

### Infectious Diseases

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<tr>
<td>701-0263-01L</td>
<td>Seminar in Evolutionary Ecology of Infectious</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>D. Croll, S. Bonhoeffer, R. R. Regös</td>
</tr>
</tbody>
</table>

**Prerequisites / notice**

Handouts are provided to students in the classroom. Language of the course is English.

**Notes**

Please mind the ETH enrolment deadlines for UZH students: https://www.ethz.ch/en/studies/non-degree-courses/special-students-university-of-zurich.html

Please check the UZH enrolment to module CS16_101 at UZH.

If you are unfamiliar with R, I highly recommend the online R course etutoR.

The statistical package R will be used in the exercises.

If you are unfamiliar with R, I highly recommend the online R course etutoR.
Evolutionary Medicine for Infectious Diseases

Objective
This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

Content
A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

Lecture notes
Publications and class notes can be downloaded from a web page announced during the lecture.

Literature
Papers will be assigned and downloaded from a web page announced during the lecture.

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Immunology: from Milestones to Current Topics

Abstract
This course explores infectious disease from both the host and pathogen perspective. Through short lectures, reading and active discussion, students will identify areas where evolutionary thinking can improve our understanding of infectious diseases and, ultimately, our ability to treat them effectively.

Objective
Students will learn to (i) identify evolutionary explanations for the origins and characteristics of infectious diseases in a range of organisms and (ii) evaluate ways of integrating evolutionary thinking into improved strategies for treating infections of humans and animals. This will incorporate principles that apply across any host-pathogen interaction, as well as system-specific mechanistic information, with particular emphasis on bacteria and viruses.

Content
We will cover several topics where evolutionary thinking is relevant to understanding or treating infectious diseases. This includes: (i) determinants of pathogen host range and virulence, (ii) dynamics of host-parasite coevolution, (iii) pathogen adaptation to evade or suppress immune responses, (iv) antimicrobial resistance, (v) evolution-proof medicine. For each topic there will be a short (~30 minutes) introductory lecture, before students independently research the primary literature and develop half a page of discussion points and questions, followed by interactive discussion in class.

Literature
Students will read the primary literature on each topic, and in places we will use the following books:

- Schmid Hempel 2011 Evolutionary Parasitology
- Stearns & Medzhitov 2016 Evolutionary Medicine

Prerequisites / notice
A basic understanding of evolutionary biology, microbiology or parasitology will be advantageous but is not essential.
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products.

A list of references will be given at the beginning of the course for the different topics presented during this course.

To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in food and consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.

There is no script. Powerpoint presentations will be made available on-line to students.

701-1471-00L Ecological Parasitology  
Lecturer M. B. Zimmermann, M. Siegrist

This course focuses on the ecology and evolution of macroparasites and their hosts. Through lectures and practical work, students learn about diversity and natural history of parasites, adaptations of parasites, ecology of host-parasite interactions, applied parasitology, and human macroparasites in the modern world.

Objective  
1. Identify common macroparasites in aquatic organisms.  
2. Understand ecological and evolutionary processes in host-parasite interactions.  
3. Conduct parasitological research.

Content  
Lectures:  
1. Diversity and natural history of parasites (i.e. systematic groups and life-cycles).  
2. Adaptations of parasites (e.g. evolution of life-cycles, host manipulation).  
3. Ecology of host-parasite interactions (e.g. parasite communities, effects of environmental changes).  
4. Applied parasitology (e.g. aquaculture and fisheries).  
5. Human macroparasites (schistosomiasis, malaria).

Practical exercises:  
1. Examination of parasites in fish (identification of species and description of parasite communities).  
2. Examination of parasites in molluscs (identification and examination of host exploitation strategies).  
3. Examination of parasites in amphipods (identification and examination of effects on hosts).

Nutrition and Health

752-2122-00L Food and Consumer Behaviour  
Lecturer C. Lacroix, C. H. Hartmann

This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.

Prerequisites / notice  
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break.

752-5103-00L Functional Microorganisms in Foods  
Lecturer C. Lacroix, T. de Wouters, L. Meile, C. Schwab

This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Probiotics

Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

752-6101-00L Dietary Etiologies of Chronic Disease  
Lecturer M. B. Zimmermann

This course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Objective  
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

Content  
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Lectures  
There is no script. Powerpoint presentations will be made available on-line to students.

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1538 of 1571
Literature
To be provided by the individual lecturers, at their discretion.

Prerequisites / notice
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

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<tr>
<td>752-6402-00L</td>
<td>Nutrigenomics</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>G. Vergères</td>
</tr>
</tbody>
</table>

Abstract
Nutrigenomics - toward personalized nutrition?
Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.

Objective
- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.
- Overall understating of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.
- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics

Content
- For the content of the script see section "Skript" below
- The lecture is completed by an optional project entitled ‘Personalized Nutrition’ in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.

Lecture notes
The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules

Module A
From biochemical nutrition research to nutrigenomics

Module B
Nutritional genomics

Module C
Nutrigenetics

Module D
Nutri-epigenomics

Module E
Transcriptomics in nutrition research

Module F
Proteomics in nutrition research

Module G
Metabolomics in nutrition research

Module H
Nutritional systems biology

Module I
Individualized nutrition - opportunities and challenges

Literature
No extra reading requested. Most slides in the lecture are referenced with web adresses.

Prerequisites / notice
Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.

Environment and Health

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<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
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</tbody>
</table>

Abstract
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

Objective
The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Content
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Lecture notes
Handouts will be distributed

Literature
Will be mentioned in handouts

Term Paper and Seminar

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Abstract
Writing of a review paper of scientific quality on a topic in the domain of Human Health, Nutrition and Environment based on critical evaluation of scientific literature.

Objective
- Acquisition of knowledge in the field of the review paper
- Assessment of original literature as well as synthesis and analysis of the findings
- Practising of academic writing in English
- Giving an oral presentation with discussion on the topic of the review paper

Content
Topics are offered in the domains of the major ‘Human Health, Nutrition and Environment’ covering ‘Public Health’, ‘Infectious Diseases’, ‘Nutrition and Health’ and ‘Environment and Health’.

Lecture notes
Guidelines will be handed out in the beginning.

Literature
Literature will be identified based on the topic chosen.
From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the group. The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences. You become acquainted with the regulative, juridical and economic requirements of project development in renewable energies in the field of wind power, solar power and hydro power. You learn to launch and judge projects by exercises in groups. You recognize chances and risks of renewable energy projects. Business models for renewable energy projects have been introduced of market trends, market structure, technical trends and regulation in Switzerland and in the EU internal energy market. Necessary frame conditions for profitable projects will be identified based on the chosen topic. The lecture contains concepts, physics and components of building technologies for the efficient and sustainable energy supply and climatisation of buildings and their interaction with architecture and urban design. Using calculations, students learn to acquire relevant numbers and assess the performance of solutions. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.

### 2G W 051-0551-00L Energy- and Climate Systems I

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>701-0967-00L</td>
<td>Project Development in Renewable Energies</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>R. Rechsteiner, A. Appenzeller, A. Wanner</td>
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<td>Objective</td>
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<td></td>
<td>The lecture contains concepts, physics and components of building technologies for the efficient and sustainable energy supply and climatisation of buildings and their interaction with architecture and urban design. Using calculations, students learn to acquire relevant numbers and assess the performance of solutions.</td>
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<td>The lecture series focuses on the physical principles and technical components of relevant systems for an efficient and sustainable climatisation and energy supply of buildings. A special focus is on the interrelation of supply systems and architectural design and construction. Learning and practicing methods of quantifying demand and supply allows identifying parameters relevant for design.</td>
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<td></td>
<td>1. Introduction</td>
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<td>2. Heating and cooling</td>
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<td>3. Active and passive ventilation</td>
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<tr>
<td></td>
<td>4. Electricity in buildings</td>
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<tr>
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<td>Literature</td>
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<tr>
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<td>The Slides from the lecture serve as lecture notes and are available as download.</td>
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<td>Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.</td>
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### 2G W 072-0731-00L Power Market I - Portfolio and Risk Management

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<tbody>
<tr>
<td>701-1346-00L</td>
<td>Carbon Mitigation</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>N. Gruber</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.</td>
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<td></td>
<td>From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group.</td>
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<td>Lecture notes</td>
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### 2G W 051-0551-00L Energy- and Climate Systems I

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<tr>
<td>051-0551-00L</td>
<td>Energy- and Climate Systems I</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>A. Schlüter</td>
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<tr>
<td></td>
<td>Objective</td>
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<td></td>
<td>The lecture series focuses on the physical principles and technical components of relevant systems for an efficient and sustainable climatisation and energy supply of buildings. A special focus is on the interrelation of supply systems and architectural design and construction. Learning and practicing methods of quantifying demand and supply allows identifying parameters relevant for design.</td>
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<td>1. Introduction</td>
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<td>2. Heating and cooling</td>
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<td>3. Active and passive ventilation</td>
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<td>4. Electricity in buildings</td>
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<td></td>
<td>Literature</td>
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<td></td>
<td>The Slides from the lecture serve as lecture notes and are available as download.</td>
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<td>Prerequisites / notice</td>
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<td></td>
<td>A list of relevant literature is available at the chair.</td>
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### 2G W 072-0731-00L Power Market I - Portfolio and Risk Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0731-00L</td>
<td>Power Market I - Portfolio and Risk Management</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>D. Reichelt, G. A. Koopell</td>
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<td>Objective</td>
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<td></td>
<td>Portfolio and risk management in the electrical power business, Pan-European power market and trading, futures and forward contracts, hedging, options and derivatives, performance indicators for the risk management, modelling of physical assets, cross-border trading, ancillary services, balancing power market, Swiss market model.</td>
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<td>Prerequisites / notice</td>
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</table>
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential

The purpose of the course is to give the participants an overview of the methods and tools used for energy systems analysis and how to


The course provides an introduction to the methods and tools for analysis of energy consumption, energy production and energy flows.


Energy System Analysis

227-1631-00L Energy System Analysis W 4 credits 3G G. Hug, S. Hellweg, F. Noembrini, A. Schlüter

The course provides an introduction to the methods and tools for analysis of energy consumption, energy production and energy flows. Environmental aspects are included as well as economical considerations. Different sectors of the society are discussed, such as electric power, buildings, and transportation. Models for energy system analysis planning are introduced.

Objective

The purpose of the course is to give the participants an overview of the methods and tools used for energy systems analysis and how to use these in simple practical examples.

Content

The course gives an introduction to methods and tools for analysis of energy consumption, energy production and energy flows. Both larger systems, e.g. countries, and smaller systems, e.g. industries, homes, vehicles, are studied. The tools and methods are applied to various problems during the exercises. Different conventions of energy statistics used are introduced.

The course provides also an introduction to energy systems models for developing scenarios of future energy consumption and production. Bottom-up and Top-Down approaches are addressed and their features and applications discussed.

The course contains the following parts:

Part I: Energy flows and energy statistics
Part II: Environmental impacts
Part III: Electric power systems
Part IV: Energy in buildings
Part V: Energy in transportation
Part VI: Energy systems models

Literature


Renewable Energy Technologies I

529-0193-00L Renewable Energy Technologies I W 4 credits 3G A. Wokaun, A. Steinfeld

The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-01L) can be taken independently from one another.

Abstract

Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.

Objective

Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content


Literature

Minor in Global Change and Sustainability

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0015-00L</td>
<td>Seminar on Transdisciplinary Research for Sustainable Development</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>C. E. Pohl, M. Stauffacher</td>
</tr>
</tbody>
</table>

Abstract: The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.

Objective: The participants understand the specific challenges of interdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

Content: The seminar covers the following topics:
- Theories and concepts of inter- and transdisciplinary research
- The specific challenges of inter- and transdisciplinary research
- Involving stakeholders
- Collaborating disciplines
- Exploration of tools and methods
- Examining and evaluating projects' attempts to improve inter- and transdisciplinary elements

Literature: Literature will be made available to the participants.

Minor in Transdisciplinarity for Sustainable Development

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>701-1551-00L</td>
<td>Sustainability Assessment</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Krüttli, C. E. Pohl</td>
</tr>
</tbody>
</table>

Abstract: The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

Objective: The course is seminar-like, interactive.

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- the respective impacts on individual and societal decision-making.

Content: The course is structured as follows:
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable local / regional development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Trade-offs in selected examples.

Literature: Handouts.

Transdisciplinary Methods and Applications

<table>
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<th>Number</th>
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<tbody>
<tr>
<td>701-1543-00L</td>
<td>Transdisciplinary Methods and Applications</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Krüttli, M. Stauffacher</td>
</tr>
</tbody>
</table>

Prerequisites: None

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

Data: 06.11.2018 12:57  Autumn Semester 2016  Page 1542 of 1571
Abstract
The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines.

Objective
At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2017

Content
The lecture is structured as follows:

- Overview of concepts and methods of inter-/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

Lecture notes
Handouts are provided by the lecturers

Literature
Selected scientific articles and book-chapters

Prerequisites / notice
This course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.

701-1551-00L Sustainability Assessment W 3 credits 2G P. Krüttli, C. E. Pohl

Abstract
The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

Objective
At the end of the course students should

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content
The course is structured as follows:

- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Trade-offs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

Minor in Life Cycle Assessment

Number Title Type ECTS Hours Lecturers
101-0577-00L An Introduction to Sustainable Development in the Built Environment W 3 credits 2G G. Habert

Abstract
This year the UN Conference in Paris will shape future world objectives to tackle climate change.

Objective
At the end of the semester, the students have an understanding of the term of sustainable development, its history, the current political and scientific discourses and its relevance for our built environment.

In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environmetal aspects.

The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.

Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.

After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.

The course offers an environmental, socio-economic and socio-technical perspective focusing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.
The following topics give an overview of the themes that are to be worked on during the lecture.

- Overview on the history and emergence of sustainable development
- Overview on the current understanding and definition of sustainable development
- Case Study 1: Sustainable construction of the role of construction industry (national/international)
- Case Study 2: Cities, forms of settlements
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Synthesis 1: Climate Change mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development

Lecture notes
All relevant information will be online available before the lectures. For each lecture slides of the lecture will be provided.

Literature
A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

102-0317-00L Advanced Environmental Assessments
Master students in Environmental Engineering choosing module Ecological Systems Design are not allowed to enrol 102-0317-00 Advanced Environmental Assessments (3KP) as already included in 102-0307-01 Advanced Environmental, Social and Economic Assessments (5KP).

Abstract
This course deepens students' knowledge of the environmental assessment methodologies and their various applications.

Objective
This course has the aim of deepening students' knowledge of the environmental assessment methodologies and their various applications. In particular, students completing the course should have the
- Ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models, and factors
- Knowledge about the current state of the scientific discussion and new research developments
- Ability to properly plan, conduct and interpret environmental assessment studies
- Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers

Content
- Inventory developments, transparency, data quality, data completeness, and data exchange formats
- Allocation (multioutput processes and recycling)
- Hybrid LCA methods
- Consequential and marginal analysis
- Recent development in impact assessment
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Uncertainty analysis
- Subjectivity in environmental assessments
- Multicriteria analysis
- Case Studies

Lecture notes
No script. Lecture slides and literature will be made available on the lecture homepage.

Literature
Literature will be made available on the lecture homepage.

Prerequisites / notice
Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done classwork in this topic before are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. 2016: Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).

102-0317-03L Advanced Environmental Assessment (Computer Lab I)

Abstract
Different tools and software used for environmental assessments, such as LCA are introduced. The students will have hands-on exercises in the computer rooms and will gain basic knowledge on how to apply the software and other resources in practice

Objective
Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.

102-0317-04L Advanced Environmental Assessment (Computer Lab II)

Abstract
Technical systems are investigated in projects, based on the software and tools introduced in the course 102-0317-03L Advanced Environ Assessment (Computer Lab I). The projects are created around a complete but simplified LCA study, where the students will learn how to answer a given question with target oriented methodologies using various software programs and data sources for env. assessment

Objective
Become acquainted with utilizing various software programs for environmental assessment to perform a Life Cycle Assessment and learn how to address the challenges when analyzing a complex system with available data and software limitations.

Prerequisites / notice
Prerequisite is enrolment of 102-0317-00 Advanced Environmental Assessments and of 102-0317-03 Advanced Environmental Assessments (Computer Lab I) in parallel or in advance (both courses in HS).

★★ Minor in Analytical Chemistry

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>529-0041-00L</td>
<td>Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>R. Zenobi, B. Hattendorf, P. Martinez-Lozano Sinues</td>
</tr>
</tbody>
</table>

Abstract
Modern mass spectrometry, hyphenated analytical methods, speciation, methods of source surface analysis, chemometrics.

Objective
Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

Content
Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation.
Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods, methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods).

Lecture notes
Employment of computer science for processing data in chemical analysis (chemometrics). Lecture notes will be available in the lecture at production cost.

Literature
Information about relevant literature will be available in the lecture & in the lecture notes.
From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>Exercises are an integral part of the lecture.</th>
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<tbody>
<tr>
<td>Prerequisites:</td>
<td>529-0051-00 &quot;Analytische Chemie I (3. Semester)&quot;</td>
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<td>529-0058-00 &quot;Analytische Chemie II (4. Semester)&quot;</td>
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<td>(or equivalent)</td>
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| 529-0043-00L | Analytical Strategy | W | 7 credits | 3G | R. Zenobi, M. Badertscher, P. S. Dittrich, D. Günther |

| Abstract | Problem-oriented development of analytical strategies and solutions. |
| Content | Individual development of strategies for the optimal application of chemical, biochemical, and physico-chemical methods in analytical chemistry solving predefined problems. Experts from industry and administration present particular problems in their field of activity. |
| Design and application of microanalytical systems. |

| Lecture notes | Copies of problem sets and solutions will be distributed free of charge. |
| Prerequisites / notice | 529-0051-00 "Analytical Chemistry I (3. Semester)" |
|                        | 529-0058-00 "Analytical Chemistry II (4. Semester)" |
| (or equivalent)        |                                               |

### Minor in Biogeochemistry

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<tbody>
<tr>
<td>701-1313-00L</td>
<td>Isotopic and Organic Tracers in Biogeochemistry</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>R. Kipfer, S. Ladd</td>
</tr>
</tbody>
</table>

| Abstract | The course introduces the scientific concepts and typical applications of tracers in biogeochemistry. The course covers stable and radioactive isotopes, geochemical tracers and biomarkers and their application in biogeochemical processes as well as regional and global cycles. The course provides essential theoretical background for the lab course "Isotopic and Organic Tracers Laboratory". |
| Content | The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radiogenic isotopes. They discover the spectrum of possible geochemical tracers and biomarkers, their potential and limitations and get familiar with important applications |
| Lecture notes | Geogenic and cosmogenic radionucleides (sources, decay chains); stable isotopes in biogeochemistry (natural abundance, fractionation); geochemical tracers for processes such as erosion, productivity, redox fronts; biomarkers for specific microbial processes. |
| Literature | A list of relevant books and papers will be provided |
| Prerequisites / notice | Students should have a basic knowledge of biogeochemical processes (BSc course on Biogeochemical processes in aquatic systems or equivalent) |

### Biogeochemistry of Trace Elements

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<tr>
<td>701-1315-00L</td>
<td>Biogeochemistry of Trace Elements</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>A. Voegelin, M. Etique, L. Winkel</td>
</tr>
</tbody>
</table>

| Abstract | The course addresses the biogeochemical classification and behavior of trace elements, including key processes driving the cycling of important trace elements in aquatic and terrestrial environments and the coupling of abiotic and biotic transformation processes of trace elements. Examples of the role of trace elements in natural or engineered systems will be presented and discussed in the course. |
| Content | The students are familiar with the chemical characteristics, the environmental behavior and fate, and the biogeochemical reactivity of different groups of trace elements. They are able to apply their knowledge on the interaction of trace elements with geosphere components and on abiotic and biotic transformation processes of trace elements to discuss and evaluate the behavior and impact of trace elements in aquatic and terrestrial systems. |
| Lecture notes | Geogenic and cosmogenic radionucleides (sources, decay chains); stable isotopes in biogeochemistry (natural abundance, fractionation); geochemical tracers for processes such as erosion, productivity, redox fronts; biomarkers for specific microbial processes. |
| Prerequisites / notice | Students are expected to be familiar with the basic concepts of aquatic and soil chemistry covered in the respective classes at the bachelor level (soil mineralogy, soil organic matter, acid-base and redox reactions, complexation and sorption reactions, precipitation/dissolution reactions, thermodynamics, kinetics, carbonate buffer system). This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory". |

### Water Resources and Drinking Water

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<tbody>
<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
</tr>
</tbody>
</table>

| Abstract | The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries. |
| Content | The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality. |
| Literature | Handouts will be distributed |

### Carbon Mitigation

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<th>Number</th>
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</thead>
<tbody>
<tr>
<td>701-1346-00L</td>
<td>Carbon Mitigation</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>N. Gruber</td>
</tr>
</tbody>
</table>

| Abstract | Future climate change can only kept within reasonable bounds when CO2 emissions are drastically reduced. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students. |
| Content | The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences. |
| Literature | None |
| Prerequisites / notice | Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion. |
After the course the students are able to understand and interpret measurements of ice flow, subglacial water pressure, and ice temperature. Upon successful completion of this course students are able to:
- assess the risk posed to the environment by landfills, contaminated sites, and radioactive waste repositories in terms of fate and transport of contaminants
- describe technologies available to minimize environmental contamination
- describe the principles in handling of contaminated sites and to propose and evaluate suitable remediation techniques
- explain the concepts that underlie radioactive waste disposal practices

This lecture course comprises of lectures with exercises and guided case studies.
- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A review of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

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<tr>
<td>101-0289-00L</td>
<td>Applied Glaciology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Funk, A. Bauder, D. Farinotti</td>
</tr>
<tr>
<td>651-1581-00L</td>
<td>Seminar in Glaciology</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>A. Bauder</td>
</tr>
<tr>
<td>651-4101-00L</td>
<td>Physics of Glaciers</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>M. Lüthi, G. Jouvet, F. T. Walter, M. Werder</td>
</tr>
<tr>
<td>651-4077-00L</td>
<td>Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)</td>
<td>W</td>
<td>3</td>
<td>1V</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A review of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
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</tr>
<tr>
<td>651-1581-00L</td>
<td>Seminar in Glaciology</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>A. Bauder</td>
</tr>
<tr>
<td>651-4101-00L</td>
<td>Physics of Glaciers</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>M. Lüthi, G. Jouvet, F. T. Walter, M. Werder</td>
</tr>
<tr>
<td>651-4077-00L</td>
<td>Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)</td>
<td>W</td>
<td>3</td>
<td>1V</td>
<td>University lecturers</td>
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</tbody>
</table>

This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A review of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>101-0289-00L</td>
<td>Applied Glaciology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Funk, A. Bauder, D. Farinotti</td>
</tr>
<tr>
<td>651-1581-00L</td>
<td>Seminar in Glaciology</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>A. Bauder</td>
</tr>
<tr>
<td>651-4101-00L</td>
<td>Physics of Glaciers</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>M. Lüthi, G. Jouvet, F. T. Walter, M. Werder</td>
</tr>
<tr>
<td>651-4077-00L</td>
<td>Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)</td>
<td>W</td>
<td>3</td>
<td>1V</td>
<td>University lecturers</td>
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</tbody>
</table>
Risks to life and human assets result when settlement areas and infrastructure overlap regions where natural hazard processes occur. This course utilizes case studies to teach how a future natural hazards-specialist should analyze, assess and manage risks.

Concepts will be explained step-by-step through a set of case studies, and applied in lab by the students. The following principal steps are used when coping with natural hazard-risks. At each step, students will learn and apply the following skills:

- Risk analysis - What can happen?
- Risk characterization and environmental measures that lead to a natural hazard and integrate modeling results of these processes.
- Identify threats to human life and assets exposed to natural hazards and estimate possible drawbacks or damages.
- Risk assessment - What are the acceptable levels of risk?
- Apply principles to determine acceptable risks to human life and assets in order to identify locations which should receive added protection.
- Explain causes for conflicts between risk perception and risk analysis.
- Risk management - What steps should be taken to manage risks?
- Explain how various hazard mitigation approaches reduce risk.
- Describe hazard scenarios as a base for adequate dimensioning of control measures.
- Identify the best alternative from a set of thinkable measures based on an evaluation scheme.
- Explain the principles of risk-governance.

The course introduces the students to engineering hydrology. It covers first physical hydrology, that is the description and the measurement of hydrological processes (precipitation, interception, evapotranspiration, runoff, erosion, snow), and it introduces then the basic mathematical models of the single processes and of the rainfall-runoff transformation, thereby including flood analysis.

1) Einführung ins Vorgehenskonzept (1W)
2) Risikoadynalyse (6W + Exkursion) mit:
- Systemabgrenzung
- Gefahrenbeurteilung
- Expositions- und Folgenanalyse
3) Risikobewertung (2W)
4) Risikomanagement (2W + Exkursion)
5) Abschlussbesprechung (1W)

The course utilizes case studies to teach how a future natural hazards-specialist should analyze, assess and manage risks.

- Explain the principles of risk-governance.
- Describe hazard scenarios as a base for adequate dimensioning of control measures.
- Explain how various hazard mitigation approaches reduce risk.
- Describe hazard scenarios as a base for adequate dimensioning of control measures.
- Identify the best alternative from a set of thinkable measures based on an evaluation scheme.
- Explain the principles of risk-governance.

Die Vorlesung besteht aus folgenden Blöcken:


Interzeption: Messung und Schätzung.

Evaporation and Evapotranspiration: Prozesse, Messung und Schätzung, potentielle und effektive Evapotranspiration, Energiebilanzmethode, empirische Methode.

Infiltration: Messung, Horton-Gleichung, empirische und konzeptionelle Methoden, F-index und Prozentuale Methode, SCS-CN Methode.


Schnee und Eis: Schneegeographie und -messungen Schätzung des Schnee- und Eisabtaufs, Temperatur-Index- und -Grad-Tag-Verfahren.


Lecture notes

Die Kopie der Folien zur Vorlesung können auf den Webseiten der Professur für Hydrologie und Wasserwirtschaft herunterladen werden.

Literature


More references in skript
Prerequisites / notice
Vorbereitende zu Hydrologie I sind die Vorlesungen in Statistik. Der Inhalt, der um ein Teil der Übungen zu behandeln und um ein Teil der Vorlesungen zu verstehen notwendig ist, kann zusammengefasst werden, wie hintereinander es beschrieben wird:
Elementare Datenverarbeitung: Hydrologische Messungen und Daten, Datenreduzierung (grafische Darstellungen und numerische Kenngrößen).

651-3525-00L
Introduction to Engineering Geology
W 3 credits 3G S. Löw

Abstract
This introductory course starts from descriptions of the behavior and phenomena of soils and rocks under near surface loading conditions and their key geotechnical properties. Lab and field methods for the characterization of soils, rocks and rock masses are introduced. Finally practical aspects of ground engineering, including tunneling and landslide hazards are presented.

Objective
Understanding the basic geotechnical and geomaterial properties and processes of rocks and soils. Understanding the interaction of rock and soil masses with technical systems. Understanding the fundamentals of geological hazards.

Content

Lecture notes
Written course documentation available under "Kursunterlagen".

Literature

Minor in Operations Eng. and Manag. for Forest and Timber Industries

Production Technology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>701-1805-00L</td>
<td>Systems Engineering Lab</td>
<td>W</td>
<td>3 credits</td>
<td>2P</td>
<td>H. R. Heinimann</td>
</tr>
<tr>
<td>101-0637-10L</td>
<td>Structures of Wood Function</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>I. Burgert, E. R. Zürcher</td>
</tr>
<tr>
<td>101-0637-20L</td>
<td>Fundamentals of Wood Elaboration and Woodmachining</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>I. Burgert, O. F. Kläusler</td>
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</table>
**Production Management**

The general introduction shows the economic relevance of the resource wood in a global, European and Swiss context and reflects aspects of sustainability in wood production and certification. In terms of bulk wood products a specific focus is laid on sawn timber production and drying processes. With regard to wood veneer production, steaming, veneer cutting and assembly to veneer lumber products are presented. Further the common technologies for the production of particle boards and fibre boards as well as paper will be discussed. In the following, the topics are related to wood gluing and wood protection as well as potentials and limitations in the application of wood and wood-based products. At the end of the lecture an excursion to a Swiss wood manufacturer is planned, in order to facilitate practical experience.

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>363-0445-00L</td>
<td>Production and Operations Management</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>T. Netland, P. Schönseleben</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This core course on Production and Operations Management provides the students insights into the basic theories, concepts, and techniques used to design, organize, and improve the operational capabilities of an organization.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Students learn why and how operations can be a competitive weapon; how to design, plan, control, and manage production and service processes; how to improve effectiveness and efficiency in operations; how to take advantage of new technological advancements; and how environmental and social concerns affect decisions in global production networks.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The course covers the most fundamental strategic and tactical concepts in production and operations management. The lectures cover: Introduction to POM; Operations strategy; Capacity management; Production planning and control; Production philosophies; Lean management; Performance measurement; Problem solving; Service operations; New technologies in POM; Servitization; Global production; and Triple-bottom line.</td>
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<tbody>
<tr>
<td>363-0445-02L</td>
<td>Production and Operations Management (Additional Cases)</td>
<td>W</td>
<td>1</td>
<td>2A</td>
<td>T. Netland, P. Schönseleben</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Extension to course 363-0445-00 Production and Operations Management.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Extension to course 363-0445-00 Production and Operations Management.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Additional cases to course 363-0445-00 Production and Operations Management.</td>
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**Environmental Management**

Master students in Environmental Engineering choosing module Ecological Systems Design are not allowed to enrol 102-0317-00 Advanced Environmental Assessments (3KP) as already included in 102-0307-01 Advanced Environmental, Social and Economic Assessments (SKP).

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>102-0317-00L</td>
<td>Advanced Environmental Assessments</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hellweg, R. Frischknecht</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This course deepens students' knowledge of the environmental assessment methodologies and their various applications. In particular, students completing the course should have the ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors. Knowledge about the current state of the scientific discussion and new research developments. Ability to properly plan, conduct and interpret environmental assessment studies. Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>No script. Lecture slides and literature will be made available on the lecture homepage.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Literature will be made available on the lecture homepage.</td>
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<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>102-0317-03L</td>
<td>Advanced Environmental Assessment (Computer Lab I)</td>
<td>W</td>
<td>1</td>
<td>1U</td>
<td>S. Pfister</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Different tools and software used for environmental assessments, such as LCA are introduced. The students will have hands-on exercises in the computer rooms and will gain basic knowledge on how to apply the software and other resources in practice.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.</td>
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<tbody>
<tr>
<td>102-0317-04L</td>
<td>Advanced Environmental Assessment (Computer Lab II)</td>
<td>W</td>
<td>2</td>
<td>2P</td>
<td>S. Pfister</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Not for master students in Environmental Engineering choosing module Ecological System Design as already included in Environmental and Computer Laboratory I (Year Course): 102-0307-00 and 102-0307-01. Technical systems are investigated in projects, based on the software and tools introduced in the course 102-0317-03L Advanced Env. Assessment (Computer Lab I). The projects are created around a complete but simplified LCA study, where the students will learn how to answer a given question with target oriented methodologies using various software programs and data sources for env. assessment.</td>
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<td><strong>Objective</strong></td>
<td>Become acquainted with utilizing various software programs for environmental assessment to perform a Life Cycle Assessment and learn how to address the challenges when analyzing a complex system with available data and software limitations.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Become acquainted with utilizing various software programs for environmental assessment to perform a Life Cycle Assessment and learn how to address the challenges when analyzing a complex system with available data and software limitations.</td>
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**Minor in Soil-Plant Relations and Land Use**
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<th>Number</th>
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<tbody>
<tr>
<td>701-1681-00L</td>
<td>Element Balancing and Soil Functions in Managed Ecosystems</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Keller</td>
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<td>Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures.</td>
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<td>The students learn to critically assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.</td>
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<td>Content</td>
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<td>The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. You assess the sustainability of current land use and analyse management options improving nutrient and metal cycling in agro-ecosystems. The students will have the opportunity to calculate specific scenarios regarding land use management and environmental changes. Special focus will be paid on the soil services such as regulation-, production function and soil as habitat, and the assessment of these functions based on soil mapping data.</td>
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<td>Lecture notes</td>
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<td>Literature and Exercises for a case study</td>
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<td>Literature will be provided.</td>
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<td>Prerequisites / notice</td>
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<td>The course consists of lectures and computer exercises. The course take place every 2 weeks à 4 hours.</td>
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<td>recommended prerequisites for attending this course:</td>
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<td></td>
<td>- Bodenschutz und Landnutzung</td>
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<td>- Biochemistry of Trace Elements</td>
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<td></td>
<td>- Angewandte Bodenökologie</td>
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<tr>
<td>751-3405-00L</td>
<td>Radio-Isotopes in Plant Nutrition</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>E. Frossard</td>
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<td>The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isotope into a system can be done to get some information on the structure of the system. Case studies will be presented to determine element availability. Finally, published studies from other groups will be analyzed and presented by the students.</td>
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<td>At the end of the course the students are familiar with the principles on which radioisotope works are based and they have learned from case studies how radioisotopes can be used to obtain meaningful data. They are aware of the advantages of using radioisotopes in element cycling studies, but also of the risks and open questions related to isotope work.</td>
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<td>Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g. exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.).</td>
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<td>The course will first present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g. number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.</td>
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<td>Lecture notes</td>
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<tr>
<td></td>
<td>Literature</td>
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<td></td>
<td>Literature will be distributed during the lecture</td>
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<td>Prerequisites / notice</td>
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<td>The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at: <a href="http://www.pe.ipw.agr.ethz.ch/about/reach">http://www.pe.ipw.agr.ethz.ch/about/reach</a></td>
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<tr>
<td>751-5101-00L</td>
<td>Biogeochemistry and Sustainable Management</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>N. Buchmann, L. Hörtnagl</td>
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<td>This course focuses on the interactions between ecology, biogeochemistry and management of agro- and forest ecosystems, thus, coupled human-environmental systems. Students learn how human impacts on ecosystems via management or global change are mainly driven by effects on biogeochemical cycles and thus ecosystem functioning, but also about feedback mechanisms of terrestrial ecosystems.</td>
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<td>Abstract</td>
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<td>The students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and forest ecosystems. They will learn to analyze and evaluate the various impacts of different environmental conditions, search literature, write and evaluate scientific reports, and be able to coordinate and work successfully in small (interdisciplinary) teams.</td>
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<td>Students learn to critically assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.</td>
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<td>The students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.</td>
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<td>Lecture notes</td>
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<td>Literature</td>
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<td>Handouts will be available on the webpage of the course.</td>
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<td></td>
<td>Will be discussed in class.</td>
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<td>Prerequisites / notice</td>
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<td>Prerequisites: Attendance of introductory courses in plant ecophysiology, ecology, and grassland or forest sciences. Course will be taught in English.</td>
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<tr>
<td>751-5123-00L</td>
<td>Rhizosphere Ecology</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>H. A. Gamper, T. I. McLaren</td>
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<td>Number of participants limited to 18.</td>
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<td>Prerequisites: Only students who have passed the courses 751-3401-00L Pflanzenährung I and 751-3402-00L Pflanzenährung II - Integriertes Nährstoffmanagement can be admitted to this course.</td>
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<td></td>
<td>Abstract</td>
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<td>This course is about the physical, chemical, and biological processes in the rhizosphere and their effect on plant growth. Effects of fertilisers, companion plants, and microbial symbionts, and other microbes on nutrient cycling and plant uptake are discussed. An “intercropping” experiment in the glasshouse is used as a model to check for rhizosphere effects on plant growth and mineral nutrition.</td>
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</table>
Objective
To gain a holistic understanding of resource-driven and regulatory processes in agricultural and natural ecosystems.
Develop skills on the critical analysis of scientific papers.
Define explanatory hypotheses, identify knowledge gaps for further investigations.
Carry out a multi-disciplinary experiment that involves aspects of soil, (micro-)biology, plant physiology, pathology, and ecology.
Develop manual skills in the set up of a glasshouse experiment, in soil and plant analyses, and in isolation and DNA-based characterisation of rhizobia.
Gain insights on basic methods to analyse (bio-)chemical, molecular genetic, and graphical data.
Discuss and interpret data in the context of the literature.
Prepare a research report in the format of a scientific paper and a poster in the format of a conference paper, partially alone and partially in small groups, using data obtained from the glasshouse experiment.

Content
This course is designed to stimulate thinking and promote critical analysis of important processes that occur in the rhizosphere. As part of this course, the knowledge acquired will be used for analysing and interpreting experimental data, as well as, preparing a scientific report and conference-type poster.

The course will cover the relative importance of spatial scales and various physicochemical and microbiological dynamics as influenced by roots. We will discuss root traits and activities that influence the immediately root-surrounding soil and thereby contribute to mineral nutrient mobilization and immobilization. An overview of the most relevant root-microbe symbioses for agroecosystems will be provided and root and microbial traits discussed, which could be of use in efforts towards utilization of intercropping and bioinoculants as a possible means of reducing energetically expensive inputs to farming systems. A special emphasis will be given to the importance of physicochemical features of soils and the chemical forms (= species) of elements important for plant uptake.

Practical experience will be gained with setting up a glasshouse experiment, soil and root sampling, basic soil and plant analyses, isolation of rhizobia, determination of the number of colony forming units (CFU), assays to screen for phosphorus and zinc solubilizing bacteria, DNA extraction, PCR amplification, and restriction fragment length polymorphism analysis (RFLP) of host range determining symbiosis-specific genes.

In short, the processes dealt with in this course occur on a small-scale and are generally (bio)chemical and microbiological in nature. Furthermore, they are generally not taken into account using current methods of agronomic management for plant production. However, they are increasingly being recognized as a potentially useful means of obtaining a resource-efficient and hence, economically and environmentally sustainable agricultural system, including for ecosystem restoration. Therefore, the course will invite for critical reflections and exemplify challenges in translating knowledge from scientific studies and ecology into application for plant production.

Lecture notes
For documentation, lecture slides and laboratory protocols will continuously be uploaded to the directory '751-5123-00L Rhizosphere Ecology' on the electronic document exchange platform ILIAS, LDA-ELBA: https://ilias-app2.let.ethz.ch/ilias.php?ref_id=10651&cmd=view&cmdClass=ilobjcoursegui&cmdNode=el:fv&baseClass=ilRepositoryGUI
This course guides students in analyzing and comprehending tropical agroecosystems. Students gain practical knowledge of field methods, enumeration, as well as, molecular detection, discrimination and identification techniques for rhizosphere and root-associated microbes. You will familiarize yourself with bacterial isolation, cultivation, and identification, and an appreciation of whole plant functioning in the ecological context. You will also familiarize yourself with bacterial isolation, cultivation, and identification, and an appreciation of whole plant functioning in the ecological context.

Soil-Plant Systems (751-3404-00L), although some thematic overlaps cannot be avoided. Special emphasis is given to plant-microbe-soil interactions and an appreciation of whole plant functioning in the ecological context. You will familiarize yourself with bacterial isolation, cultivation, and identification, and an appreciation of whole plant functioning in the ecological context. You will also familiarize yourself with bacterial isolation, cultivation, and identification, and an appreciation of whole plant functioning in the ecological context.

We ask all course attendees of the agricultural sciences to have passed the exams at the end of the lectures Plant Nutrition I and II (Nutrient cycling in agroecosystems) by Prof. E. Frossard. All others, have to have successfully worked through the e-learning module Plant Nutrition I by Prof. E. Frossard.

https://moodle-app2.let.ethz.ch/course/view.php?id=279

Prerequisites / notice

We ask all course attendees of the agricultural sciences to have passed the exams at the end of the lectures Plant Nutrition I and II (Nutrient cycling in agroecosystems) by Prof. E. Frossard. All others, have to have successfully worked through the e-learning module Plant Nutrition I by Prof. E. Frossard.

https://moodle-app2.let.ethz.ch/course/view.php?id=279

Remark: The course is designed to be complementary to those on Radiosotopes in Plant Nutrition (751-3405-00L), and Nutrient Fluxes in Soil-Plant Systems (751-3404-00L), although some thematic overlaps cannot be avoided. Special emphasis is given to plant-microbe-soil interactions and an appreciation of whole plant functioning in the ecological context. You will familiarize yourself with bacterial isolation, cultivation, enumeration, as well as, molecular detection, discrimination and identification techniques for rhizosphere and root-associated microbes.

Marking will consider the efforts and outcome of work by the individual participant as well as results of work in small groups. Activities for the course will result in posters and reports in the format of a conference and scientific paper. Reports will be due on Friday January 6, 2017.

Maximum number of participants: 18 (Attention: Admission will be on a first come first served basis - inscribe early!). Students of D-USYS will be reimbursed via bank transfer for train and bus tickets of the zones 121 and 122 (Please send all tickets with the bank details to Christiane Gujan (http://www.plantnutrition.ethz.ch/the-group/people-a-z/person-detail.html?persID=85593)).

Publications

Can microbes feed the world? (Society for general microbiology) http://www.sgm.ac.uk/en/publications/microbiology-today/past-issues.cfm/publication/can-microbes-feed-the-world

Ecological understanding (Second Edition)


Plant soil systems and landscape management in the food chain. Environmental Science & Technology 8: 6523-6530.


How microbes can feed the world (American Academy of Microbiology) http://academy.asm.org/index.php/browse-all-reports/800-how-microbes-can-help-feed-the-world


http://www.the-scientist.com/?articles.view/articleNo/30950/title/The-Root-of-the-Problem/


http://www.nature.com/scitable/knowledge/library/plant-soil-interactions-nutrient-uptake-105289112

https://moodle-app2.let.ethz.ch/course/view.php?id=279

Autumn Semester 2016

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Data: 06.11.2018 12:57
Lectures and exercises:
(1) Introduction to international soil classification with focus on tropical soils
(2) Soil suitability (chemical, physical and biological fertility) for tropical crops
(3) Soil conservation practices and stakeholder involvement
(4) Approaches to analyzing tropical agroecosystems

Field project:
(5) Overview of the major land use systems in Western Kenya
(6) Analysis of agricultural production systems
(7) Hands-on training on the use of field methods, diagnostic tools and survey methods
(8) Collaboration in international student teams (MSc students from Switzerland, Belgium and Kenya)

Literature


Prerequisites / notice
The number of participants is limited to 12 students due to capacity limitations for the field project in Kenya. Selection of participants will be based on (1) the student’s motivation statement, (2) successful participation in the BSc lectures “Sustainable Agroecosystems I + II” and (3) related topic for BSc thesis/ tentative topic for MSc thesis. The motivation statement is due in the first week of the semester.

103-0317-00L Sustainable Spatial Development I

<table>
<thead>
<tr>
<th>Objective</th>
<th>3 credits</th>
<th>2G</th>
<th>B. Scholl</th>
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<tbody>
<tr>
<td>Only for master students, otherwise a special permission by the lecturer is required.</td>
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</table>

Abstract
The lectures impart important knowledge for solving spatial relevant conflicts and problems. Case studies will be used to demonstrate the implementation in practice.

Objective
Spatial development deals with the development and the design of our living space. To meet the expectations, the interests and the plans of the different actors, it is needed a planning approach considering the overview of both the actual and future situation.

The concept of sustainable development in spatial planning leads necessarily to an efficient management of the resources, especially regarding the resource land. The basics of this important discipline will be the subject of this lecture, which is therefore organised in three parts:
- Inner development
- Integrated spatial and infrastructure development
- Cross-border issues in spatial development

Contents
Tasks of Spatial Planning and development
Issues of local and supra-local interest
Recurring spatial changes, impacts and key figures
Formal and informal instruments and procedures in spatial planning
Spatial Design - Ideas about the future
Reasoning and assessing the situation in spatial planning
Spatial planning as a sequence of decisions and interventions
Process and procedures management
Focus issues - Inner development before external development
Focus issues - Cross-border tasks
Focus Issues - Integrated spatial and infrastructure development

Lecture notes
Further information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.

103-0435-01L Land Management

<table>
<thead>
<tr>
<th>Objective</th>
<th>5 credits</th>
<th>4G</th>
<th>G. Nussbaumer, F. Frei, M. Huhmann, R. Michelon</th>
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</thead>
<tbody>
<tr>
<td>First part: Spatial planning on the Commune level with focus on the special land use management</td>
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<td>Second part: land re-allocation as an instrument of spatial planning; specific explanations for land re-allocations in rural regions and in construction zones.</td>
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<td>Third part: land marketing: the view of investors.</td>
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</table>

Abstract
Getting knowledge in spatial planning and land re-allocation as an interactive process.

Objective
PART 1: Spatial Planning and Special Land Use Management
- Overview about Spatial Planning on the commune level
- workflows and planning methods on the commune level
- comprehension of the public
- getting knowledge of the special land use management

PART 2: Methods of Land Re-Allocation
- Intensions and principles of land re-allocation
- implementation of the land re-allocation
- land re-allocation in construction zones
- amelioration

PART 3: Agricultural Planning

Lecture notes
Lecture notes and slides (in German) can be downloaded from the PLUS homepage.

Download: http://www.irl.ethz.ch/plus/education

Literature
References in the lecture notes

701-1695-00L Soil Science Seminar

<table>
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<tr>
<th>Objective</th>
<th>0 credits</th>
<th>1S</th>
<th>R. Schulin</th>
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<tbody>
<tr>
<td>Invited external speakers present their research on current issues in the field of soil science and discuss their results with the participants. The program will be announced through various channels and also be made available through the teaching materials.</td>
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Master and PhD students are introduced to current areas of research in soil sciences and get first-hand experience in scientific discussion.

Minor in Agricultural Plant Production and Environment
<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-4001-00L</td>
<td>Forage Cropping</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>N. Buchmann, A. Lüscher</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is an introduction into forage cropping and grassland sciences. Topics include: extensive/intensive use, grassland evaluation, grassland maintenance, management using fertilization, cutting, etc. Relationships between site, vegetation composition and management will be explored.</td>
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<tr>
<td>Objective</td>
<td>Die Studierenden werden wichtige Mischungen und Pflanzengemeinschaften mitteleuropäischer Grasslandökosysteme kennen, klassische und aktuelle Arbeiten der Bestandesskopiologie kennen, in der Lage sein, den Einfluss von Umweltfaktoren und Bewirtschaftung nicht nur auf Einzelpflanzen, sondern auf Pflanzenbestände und ihre Erträge abzuschätzen, und üben, ein wissenschaftliches Thema schriftlich prägnant zusammenzufassen.</td>
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<tr>
<td>Content</td>
<td>In diesem Kurs werden die verschiedenen Typen des Futterbaus und die wichtigsten Mischungen, aber auch natürliche Pflanzengemeinschaften in Mitteleuropa vorgestellt (Bestandesbeurteilung). Basierend auf der Ökophysiologie von Einzelpflanzen wird die Ökophysiologie von Pflanzenbeständen erarbeitet. Es werden verschiedene Arten der Bewirtschaftung vorgestellt (z. B. Bestandeslenkung durch Düngung, Beweidung, Schnitttermine, etc.) und ihre Auswirkungen auf die Bestandeszusammensetzung und auf die Erträge diskutiert. Feedback-Mechanismen zwischen Umwelt und Futterbausystemen werden angesprochen.</td>
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<td>Lecture notes</td>
<td>Handouts werden auf dem Netz zur Verfügung gestellt.</td>
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<tr>
<td>Literature</td>
<td>Wird in der Veranstaltung angesprochen.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Course will be given in German. Course builds on the Ertrags- und Ökophysiologie lecture and provides the basics for the Graslandsysteme.</td>
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<tr>
<td>751-4104-00L</td>
<td>Alternative Crops</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>A. Walter, B. Büter, E. A. Pérez Torres</td>
</tr>
<tr>
<td>Abstract</td>
<td>Few crops dominate the crop rotations worldwide. Following the goal of an increased agricultural biodiversity, species such as buckwheat but also medicinal plants might become more important in future. The biology, physiology, stress tolerance and central aspects of the value-added chain of the above-mentioned and of other alternative crops will be depicted.</td>
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<td>Objective</td>
<td>During this course, students learn to assess the potential of different minor or alternative crops compared to the dominant major crops based on their biological and agronomical features. Each student will assess and present a specific alternative crop of his or her choice based on information from scientific articles and Wikipedia. Wikipedia-entries will be generated.</td>
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<td>Prerequisites / notice</td>
<td>Students signing up for this class should have a strong interest in tropical agriculture and science communication.</td>
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<tr>
<td>751-4003-01L</td>
<td>Current Topics in Grassland Sciences (HS)</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>N. Buchmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and bioecology to management aspects in agro- and forest ecosystems.</td>
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<td>Objective</td>
<td>Students will be able to understand and evaluate experimental design and data interpretation of on-going studies, be able to critically analyze published research results, practice and present research results in the public, and gain a broad knowledge of recent research and current topics in agro- and forest ecosystem sciences.</td>
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<tr>
<td>Content</td>
<td>Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and bioecology to management aspects in agro- and forest ecosystems.</td>
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<tr>
<td>751-4701-00L</td>
<td>Herbology</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>B. Streit, N. Delabays, U. J. Haas</td>
</tr>
<tr>
<td>Abstract</td>
<td>The focus will be on the basic principles of biology and ecology of weeds, crop-weed interactions and basic knowledge of chemical, physical and biological weed control with their respective (dis-) advantages. Furthermore students will get an introduction on the mechanisms of weed management in different farming systems and crops.</td>
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<tr>
<td>751-4001-00L</td>
<td>Forage Cropping</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>N. Buchmann</td>
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<tr>
<td>Abstract</td>
<td>Presentation of the central crops of our regions (cereals, oil and fibre plants, legumes, root and tuber plants) with respect to their biology, site requirements, reaction to environmental conditions and farming practice. A few crops of other regions will be discussed for these aspects as well.</td>
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<tr>
<td>Objective</td>
<td>During this course, students acquire essential knowledge on agriculturally relevant aspects of crop biology, Via lectures and ‘hands-on’ teaching elements, differences between species as well as common aspects of different species will be experienced. Thereby, the foundation will be laid for a more intense examination of alternative crops, cropping systems and of procedures to characterize geno- and phenotype.</td>
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<td>751-5001-00L</td>
<td>Agroecologists without Borders</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>C. Decock, A. Hofmann, J. Six</td>
</tr>
<tr>
<td>Abstract</td>
<td>In this seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.</td>
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<tr>
<td>Objective</td>
<td>(1) Students analyze concrete examples of agricultural development projects in tropical agroecosystems. (2) Students broaden their understanding of environmental and socio-economic challenges of smallholder farmers. (3) Students articulate complexity and challenges in agricultural development interventions. (4) Students develop their science communication skills by producing science communication materials in the context of the given case study.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prior participation in the lecture Nachhaltige Agrarökosysteme I (Sustainable Agroecosystems I) 751-5000-00G (in spring semester) recommended; classes taught mostly in English</td>
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<tr>
<td>751-5003-00L</td>
<td>Sustainable Agroecosystems II</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>J. Six, A. Hofmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This class is intended to convey methods of agroecological research through selected case studies from current research projects and hands-on exercises. Students will gain an overview on actors in the field of sustainable agricultural development.</td>
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<tr>
<td>Objective</td>
<td>(1) Get to know methods for field and laboratory investigations in agroecology, (2) Analyze case studies from current agroecological research, (3) Place institutions and related projects into the context of sustainable agricultural development</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Minor in Environmental, Resource and Food Economics</td>
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### Minor in Environmental, Resource and Food Economics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-0537-00L</td>
<td>Resource and Environmental Economics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. Bretschger, A. Brausmann</td>
</tr>
</tbody>
</table>
Abstract
Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

Objective
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Feasibility according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

Content
- Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes
Learning material and script can be found here:
https://moodle-app2.let.ethz.ch/course/view.php?id=328

Literature

751-1555-00L
Applied Food Industrial Organisation
W 3 credits 2G to be announced

Abstract
Concepts of microeconomics and Industrial Organization and their application to the European food sector. Aspects include industry structure as well as strategic actions and performance of food sector firms.

Objective
Understanding and application of theoretical concepts along the Structure-Conduct-Performance paradigm. Ability to apply theory to empirical settings; understand and critically evaluate empirical industrial organization research and to replicate the results of such research using econometric methods.

Content
- Introduction IO
  - Relevant topics for the food sector
  - high competition and market saturation
  - low R&D intensity
  - bargaining power of retailers
  - Private label introduction
- Theoretical Approaches
  - Structure Conduct Performance
  - Market Based View
  - Porters Five Forces
  - Resource Based View
  - Knowledge Based View
- Empirical Issues (Based on published research papers)
  - Competition / Concentration
  - Profitability
  - Impact of Innovation / R&D
  - Efficiency
  - Market power
  - Econometric Approaches

Literature
Several theoretical and empirical IO related research papers

751-2103-00L
Socioeconomics of Agriculture
W 2 credits 2V S. Mann

Abstract
The main part of this lecture will examine constellations where hierarchies, markets or cooperation have been observed and described in the agricultural sector. On a more aggregated level, different agricultural systems will be evaluated in terms of main socioeconomic parameters like social capital or perceptions.

Objective
Students should be able to describe the dynamics of hierarchies, markets and cooperation in an agricultural context.
The course introduces students to foundational texts that led to the emergence of the environment as a subject of scientific importance, which such cooperation and the respective public policies are effective and/or efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory.

Lecture notes Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link ‘Registered students, please click here for course materials’ at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike.Hudecheck@student.ethz.ch). All assigned papers must be read ahead of the respective meeting. Following the course on the basis of on-line slides and papers alone is not sufficient. Physical presence in the classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GESS library at the IFW building, Haldeneggsteig 4, B-floor, or in the library of D-USYS.

Literature Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link ‘Registered students, please click here for course materials’ at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike.Hudecheck@student.ethz.ch).

Prerequisites / notice None

### Electives

#### Other

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0019-00L</td>
<td>Readings in Environmental Thinking</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>J. Ghazoul, G. Hirsch Hadorn, A. Patt</td>
</tr>
</tbody>
</table>

**Abstract**

This course introduces students to foundational texts that led to the emergence of the environment as a subject of scientific importance, and shaped its relevance to society. Above all, the course seeks to give confidence and raise enthusiasm among students to read more widely around the broad subject of environmental sciences and management both during the course and beyond.

**Objective**

The course will provide students with opportunities to read, discuss, evaluate and interpret key texts that have shaped the environmental movement and, more specifically, the environmental sciences. Students will gain familiarity with the foundational texts, but also understand the historical context within which their academic and future professional work is based. More directly, the course will encourage debate and discussion of each text that is studied, from both the original context as well as the modern context. In so doing students will be forced to consider and justify the current societal relevance of their work.

**Content**

The course will be run as a book reading club. The first session will provide a short introduction as to how to explore a particular text (that is not a scientific paper) to identify the key points for discussion.

Thereafter, in each week a text (typically a chapter from a book or a paper) considered to be seminal or foundational will be assigned by a course lecturer. The lecturer will introduce the selected text with a brief background of the historical and cultural context in which it was written, with some additional biographical information about the author. He/she will also briefly explain the justification for selecting the particular text.

The students will read the text, with two to four students (depending on class size) being assigned to present it at the next session. Presentation of the text requires the students to prepare by, for example:

- identifying the key points made within the text
- identifying issues of particular personal interest and resonance
- considering the impact of the text at the time of publication, and its importance now
- evaluating the text from the perspective of our current societal and environmental position

Such preparation would be supported by a mid-week tutorial discussion (about 1 hour) with the assigning lecturer.

These students will then present the text (for about 15 minutes) to the rest of the class during the scheduled class session, with the lecturer facilitating the subsequent class discussion (about 45 minutes). Towards the end of the session the presenting students will summarise the emerging points (5 minutes) and the lecturer will finish with a brief discussion of how valuable and interesting the text was (10 minutes). In the remaining 15 minutes the next text will be presented by the assigning lecturer for the following week.
The specific texts selected for discussion will vary, but examples include:

- Leopold (1949) A Sand County Almanach
- Carson (1962) Silent Spring
- Jared Diamond (2005) Collapse

Discussions might also encompass films or other forms of media and communication about nature.

**701-0337-00L Environmental Mineralogy**

**Abstract**
The lecture Environmental Mineralogy provides an outline of chemical and physical properties of iron oxides, clays, and carbonates. Analytical methods (XRD, spectroscopy and magnetics) are presented in order to identify and characterize minerals in natural samples as well as for the reconstruction of weathering in soils, of diagenesis in sediment, and of phase transitions in hydrothermal systems.

**Objective**
Knowledge of the most important minerals (Fe-oxides, carbonates, and sheet silicates) in environmental systems
Knowing about the technical and analytical tools for the identification and characterization of mineral phases.
Development of strategies for the analytical handling of multimodal systems.
The application of mineralogical informations to solve specific environmental problems.

**Content**
Short introduction to mineral sciences
Inorganic minerals and biominerals
Analytical methods for the identification and characterization of minerals
Weathering & diagenesis and the formation of minerals
Minerals as environmental indicators (tropical soils and lacustrine sediments as case studies)
The use of minerals in the environmental management (e.g. controlled landfills)
Weathering and conservation of building materials

**Lecture notes**
Hand-outs are delivered

**Literature**

**Prerequisites / notice**
Voraussetzungen: Bodenchemie

**5 credits**

**701-0901-00L ETH Week 2016: Challenging Water**

**Abstract**
The ETH Week is an innovative one-week course designed to foster critical thinking and creative learning. Students from all departments as well as professors and external experts will work together in interdisciplinary teams. They will develop interventions that could play a role in solving some of our most pressing global challenges. In 2016, ETH Week will focus on the topic of water.

**Objective**
- Domain specific knowledge: Students have immersed knowledge about a certain complex, societal topic which will be selected every year. They understand the complex system context of the current topic, by comprehending its scientific, technical, political, social, ecological and economic perspectives. The focus in 2016 is on challenging water systems.
- Analytical skills The ETH Week participants are able to structure complex problems systematically using selected methods. They are able to acquire further knowledge and to critically analyze the knowledge in interdisciplinary groups and with experts and the help of team tutors.
- Design skills: The students are able to use their knowledge and skills to develop concrete approaches for problem solving and decision making to a selected problem statement, critically reflect these approaches, assess their feasibility, to transfer them into a concrete form (physical model, prototypes, strategy paper,..) and to present this work in a creative way (role-plays, videos, exhibitions, etc.).
- Self-competence: The students are able to plan their work effectively, efficiently and autonomously. By considering approaches from different disciplines they are able to make a judgment and form a personal opinion. In exchange with non-academic partners from business, politics, administration, nongovernmental organizations and media they are able to communicate appropriately, present their results professionally and creatively and convince a critical audience.
- Social competence: The students are able to work in multidisciplinary teams, i.e. they can reflect critically their own discipline, debate with students from other disciplines and experts in a critical-constructive and respectful way and can relate their own positions to different intellectual approaches. They can assess how far they are able to actively make a contribution to society by using their personal and professional talents and skills and as "Change Agents".

**Content**
The week is mainly about problem solving and design thinking applied to the complex world of water. During ETH Week students will have the opportunity to work in small interdisciplinary groups, allowing them to critically analyze both their own approaches and those of other disciplines, and to integrate these into their work.

While deepening their knowledge about how the food system works, students will be introduced to various methods and tools for generating creative ideas and understand how different people are affected by each part of the system. In addition to lectures and literature, students will acquire knowledge via excursions into the real world, empirical observations, and conversations with researchers and experts

A key attribute of the ETH Week is that students are expected to find their own problem, rather than just solve the problem that has been handed to them. Therefore, the first three days of the week will concentrate on identifying a problem the individual teams will work on, while the last two days are focused on generating solutions and communicating the team's ideas.

A panel of experts will judge your presentations at the end of the week. The winning teams will receive attractive prizes.

**Prerequisites / notice**
No prerequisites. Program is open to Bachelor and Masters from all ETH Departments. All students must apply through a competitive application process that will open in March 2016 at www.ethz.ch/ETHWeek. Participation is subject to successful selection through this competitive process.
The goal of this course is to engage students in a multidisciplinary collaboration to tackle real world problems. Following a design thinking approach, students will work in teams to solve a set of design challenges that are organized as a one-week, a three-week, and a final six-week project in collaboration with an external project partner.

During the course, students will learn about different design thinking methods and tools. This will enable them to:
- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

The students experience political/legal, economic, social and psychological aspects in a professional working environment and acquire key skills such as communication and planning skills, cooperation with non-specialists or recognition of relevant aspects. Further they make useful contacts for starting their careers.

Design Thinking is a deeply human process that taps into the creative abilities we all have, but that get often overlooked by more conventional problem solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as functional, and to express ourselves through means beyond words or symbols. Design Thinking provides an integrated way by incorporating tools, processes and techniques from design, engineering, the humanities and social sciences to identify, define and address diverse challenges. This integration leads to a highly productive collaboration between different disciplines.

For more information and the application visit: http://sparklabs.ch/ethz

Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

Course Catalogue of ETH Zurich

Work Experience

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1001-00L</td>
<td>Internship ■ Only for Environmental Sciences MSc.</td>
<td>O</td>
<td>30 credits</td>
<td></td>
<td>A. Funk</td>
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</tbody>
</table>

Abstract
In the mandatory internship outside of ETH, the students in Environmental Sciences learn about how environmental issues are handled professionally through their own practical work and by applying the knowledge they acquired. They will analyse complex environmental problems on scientific, technical and social levels and develop solutions in conjunction with social actors.

Objective
The students experience political/legal, economic, social and psychological aspects in a professional working environment and acquire key skills such as communication and planning skills, cooperation with non-specialists or recognition of relevant aspects. Further they make useful contacts for starting their careers.

Content
This internship takes place outside of ETH. The main locations of an internship are the following: environmental consulting firms, planning and engineering offices, industrial and service companies, public administration, environmental organisations (nature conservation and protection, development cooperation).

The internship is a mandatory part of the two-year Master programme and lasts for at least 18 weeks (30 credit points). The internship agreement is a condition for the performance assessment of the internship.

Lecture notes
Instructions for the mandatory internship during the Master programme see www.usys.ethz.ch/en/studies/environmental-sciences/master/internship.html

Prerequisites / notice
The following sources of information are available to help you with your search:
- Register of Swiss companies offering internships www.intranet.usys.ethz.ch/UMNW/berufspraxis/Praxisregister
- Open internship positions www.intranet.usys.ethz.ch/UMNW/stellen-plattform/Stellen
- Previous internship reports www.intranet.usys.ethz.ch/UMNW/berufspraxis/Berufspraxisarbeiten
- Meeting with the internship advisor: Andrea Funk, berufspraxis@usys.ethz.ch

The internship agreement is a condition for the performance assessment of the internship and has to be approved by the internship advisor.

Master's Thesis

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1002-00L</td>
<td>Master's Thesis ■ Only students who fulfill the following criteria are allowed to begin with their Master thesis: a) The signed request for the Bachelor's Degree Certificate has been submitted (if the Bachelor's programme has been finished at ETHZ), b) At least 32 CP of coursework related to the major have been acquired, c) All additional requirements (as stated in the admissions decision), including any assessment repetitions, are fulfilled.</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Lecturers</td>
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</table>

Abstract
The course is completed by a Master thesis. This component is designed to enable the students to explore how the course content can be applied to an actual scientific problem. The thesis also provides an opportunity for the students to exercise initiative and to demonstrate that they are capable of working independently and in a scientifically structured manner.

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1558 of 1571
Objective
This component is designed to enable the students to explore how the course content can be applied to an actual scientific problem. The thesis also provides an opportunity for the students to exercise initiative and to demonstrate that they are capable of working independently and in a scientifically structured manner.

Course Units for Additional Admission Requirements
The courses below are only available for Master students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>406-0062-AAL</td>
<td>Physics I (only for MSc students)</td>
<td>E-</td>
<td>5</td>
<td>11R</td>
<td>A. Vaterlaus</td>
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<tr>
<td></td>
<td>Enrolment only for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
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<td></td>
<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
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<tr>
<td>Abstract</td>
<td>Introduction to the concepts and tools in physics: mechanics of point-like and rigid bodies, elasticity theory, elements of hydrostatics and hydrodynamics, periodic motion and mechanical waves.</td>
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<tr>
<td>Objective</td>
<td>Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.</td>
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<td></td>
<td>Chapters: 1, 2, 3, 4, 5, 6 (without: 6-5, 6-6, 6-8), 7, 8 (without 8-9), 9, 10 (without 10-10), 11 (without 11-7), 13 (without 13-13, 13-14), 14 (without 14-6), 15 (without 15-3, 15-5)</td>
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<tr>
<td>Literature</td>
<td>see &quot;Content&quot;</td>
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<td></td>
<td>Friedhelm Kuypers</td>
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<td></td>
<td>Physik für Ingenieure und Naturwissenschaftler</td>
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<tr>
<td></td>
<td>Band 1: Mechanik und Thermodynamik</td>
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<tr>
<td></td>
<td>Wiley-VCH Verlag, 2002, 544 S, ca.: Fr. 68.-</td>
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<tr>
<td>406-0063-AAL</td>
<td>Physics II (only for MSc students)</td>
<td>E-</td>
<td>5</td>
<td>11R</td>
<td>A. Vaterlaus</td>
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<td>Enrolment only for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
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<td></td>
<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
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<tr>
<td>Abstract</td>
<td>Introduction to the &quot;way of thinking&quot; and the methodology in Physics. The Chapters treated are Magnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena.</td>
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<td>Objective</td>
<td>Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.</td>
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<td></td>
<td>Band 2 Elektrizität, Optik, Wellen</td>
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<td></td>
<td>Wiley-VCH, Verlag, 2003, Fr. 77.-</td>
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<tr>
<td>406-0251-AAL</td>
<td>Mathematics I (only for MSc students)</td>
<td>E-</td>
<td>6</td>
<td>13R</td>
<td>A. Cannas da Silva</td>
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<td></td>
<td>Enrolment only for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
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</tr>
<tr>
<td>Abstract</td>
<td>This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.</td>
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<tr>
<td>Objective</td>
<td>Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.</td>
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<tr>
<td>Content</td>
<td>The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.</td>
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<tr>
<td></td>
<td>1. Linear Algebra and Complex Numbers: systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.</td>
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<td></td>
<td>3. Ordinary Differential Equations: separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.</td>
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<td></td>
<td></td>
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<tr>
<td>Literature</td>
<td>- Bretschger, O.: Linear Algebra with Applications (Pearson Prentice Hall)</td>
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</tbody>
</table>
Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.

Assistance: Tuesdays and Wednesdays 17-19h, in Room HG E 41.

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Prerequisite</th>
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<tr>
<td>406-0252-AAL</td>
<td>Mathematics II</td>
<td>7</td>
<td>15R</td>
<td>A. Cannas da Silva</td>
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<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
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<tr>
<td></td>
<td>Abstract: Continuation of the topics of Mathematics I. Main focus: multivariable calculus and partial differential equations.</td>
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<tr>
<td></td>
<td>Objective: Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.</td>
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<td>- Multivariable Differential Calculus: functions of several variables, partial differentiation, curves and surfaces in space, scalar and vector fields, gradient, curl and divergence.</td>
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<td></td>
<td>- Multivariable Integral Calculus: multiple integrals, line and surface integrals, work and flux, Green, Gauss and Stokes theorems, applications.</td>
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<td></td>
<td>- Partial Differential Equations: separation of variables, Fourier series, heat equation, wave equation, Laplace equation, Fourier transform.</td>
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<th>ECTS</th>
<th>Prerequisite</th>
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</thead>
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<td>Mathematics I &amp; II</td>
<td>13</td>
<td>28R</td>
<td>A. Cannas da Silva</td>
</tr>
<tr>
<td></td>
<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
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<tr>
<td></td>
<td>Abstract: Mathematics I covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations. Main focus of Mathematics II: multivariable calculus and partial differential equations.</td>
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<td>4. Multivariable Differential Calculus: functions of several variables, partial differentiation, curves and surfaces in space, scalar and vector fields, gradient, curl and divergence.</td>
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<td>5. Multivariable Integral Calculus: multiple integrals, line and surface integrals, work and flow, Green, Gauss and Stokes theorems, applications.</td>
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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>ECTS</th>
<th>Prerequisite</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0603-AAL</td>
<td>Stochastics (Probability and Statistics)</td>
<td>4</td>
<td>9R</td>
<td>M. Kalisch</td>
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<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
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<tr>
<td></td>
<td>Abstract: Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.</td>
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<td></td>
<td>Objective: The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language &quot;R&quot;.</td>
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</table>
Abstract
General Chemistry I and II: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium, kinetics, acids and bases, electrochemistry

Objective
Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

Content
1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)
7. Electrochemistry

Lecture notes
Nivaldo J. Tro
Chemistry - A molecular Approach (Pearson), Chapter 1-18

Literature
Housecroft and Constable, CHEMISTRY
Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY

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Abstract
Organismic biology to teach the basic principles of classical and molecular genetics, evolutionary biology and phylogeny.

Objective
The understanding of basic principles of biology (inheritance, evolution and phylogeny) and an overview of the diversity of life.

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

From within the ETH, this book is freely available online under:
http://www.springerlink.com/content/m1757b/

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Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

From "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
From within the ETH, this book is freely available online under:

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Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

From within the ETH, this book is freely available online under:
**Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between:**

- Atmosphere
- R. Aebersold, Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.
- General Biology II
  - The first semester focuses on the organismal biology aspects of genetics, evolution and diversity of life in the Campbell chapters 12-34.
  - No script
  - U. Sauer, Molecular biology approach to teach the basic principles of biochemistry, cell biology, cgenetics, evolutionary biology and form and function of vascular plants.

**Lecture notes**
- No script

**Literature**

**Prerequisites / notice**
- This is a virtual self-study lecture for non-German speakers of the "Allgemeine Biology I (551-0001-00L) lecture. The exam will be written jointly with the participants of this lecture.
- Example exam questions will be discussed during the lectures, and old exam questions are kept by the various student organisations. If necessary, please contact Prof. Uwe Sauer (sauer@ethz.ch) for details regarding the exam.

### 551-0002-AAL General Biology II

**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

**Abstract**
- Molecular biology approach to teach the basic principles of biochemistry, cell biology, cgenetics, evolutionary biology and form and function of vascular plants.

**Objective**
- The understanding basic concepts of biology: the hierarchy of the structural levels of biological organisation, with particular emphasis on the cell and its molecular functions, the fundamentals of metabolism and molecular genetics, as well as form and function of vascular plants.

**Content**
- The structure and function of biomacromolecules; basics of metabolism; tour of the cell; membrane structure and function; basic energetics of cellular processes; respiration, photosynthesis; cell cycle, from gene to protein; structure and growth of vascular plants, resource acquisition and transport, soil and plant nutrition.

Specifically the following Campbell chapters will be covered:

- 3 Biochemistry
- 3 Biochemistry
- 4 Biochemistry
- 5 Biochemistry
- 7 Cell biology
- 8 Cell biology
- 10 Cell biology
- 11 Cell biology
- 16 Genetics
- 17 Genetics
- 18 Genetics
- 19 Genetics
- 35 Plant structure&function
- 36 Plant structure&function
- 37 Plant structure&function
- 38 Plant structure&function
- 39 Plant structure&function

### 701-0023-AAL Atmosphere

**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

**Abstract**
- Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Objective**
- Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

**Content**
- Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.
**Lecture notes**

Written information will be supplied.


**701-0243-AAL Biology III: Essentials of Ecology**

**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

**Abstract**

This course assigns reading for students needing further background for understanding ecological processes. Central problems in ecology, including population growth and regulation, the dynamics of species interactions, the influence of spatial structure, the controls over species invasions, and community responses to environmental change will be explored from basic and applied perspectives.

**Objective**

Original language Students will understand how ecological processes operate in natural communities. They will appreciate how mathematical theory, field experimentation, and observational studies combine to generate a predictive science of ecological processes.

Upon completing the course, students will be able to:

- Understand the factors determining the outcome of species interactions in communities, and how this information informs management.
- Apply theoretical knowledge on species interactions to predict the potential outcomes of novel species introductions.
- Understand the role of spatial structure in mediating population dynamics and persistence, species interactions, and patterns of species diversity.
- Use population and community models to predict the stability of interactions between predators and prey and between different competitors.

**Content**

Readings from a text book will focus on understanding central processes in community ecology. Topics will include demographic and spatial structure, consumer resource interactions, food webs, competition, invasion, and the maintenance of species diversity. Each of these more conceptual topics will be discussed in concert with their applications to the conservation and management of species and communities in a changing world.

**701-0401-AAL Hydrosphere**

**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

**Abstract**

Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

**Objective**

Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

**Content**

Topics of the course.

- Physical properties of water (i.e. density and equation of state)
- Exchange at boundaries
- Energy (thermal & kinetic), gas exchange
- Mixing and transport processes in open waters
- Vertical stratification, large scale transport
- Turbulence and mixing
- Mixing and exchange processes in rivers
- Groundwater and its dynamics
- Ground water as part of the terrestrial water cycle
- Ground water hydraulics, Darcy's law
- Aquifers and their properties
- Hydrochemistry and tracer
- Ground water use
- Case studies
- 1. Water as resource, 2. Water and climate

**701-0501-AAL Pedosphere**

**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

**Abstract**

In addition to the self-learning literature handouts are distributed.

**Literature**

Textbooks for self-studying.

  - Chapter 4: Imboden, D.M., and Wüest, A. 'Mixing Mechanisms in Lakes'
  - Chapter 6.4: Air-Water Partitioning
  - Chapter 19.2: Bottleneck Boundaries
- Ground water:
    - Chapters 1 - 6, 8, 10, 11.

Optional additional readers.

Abstract
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties.

Objective
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties.

Content
Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

Literature

Prerequisites / notice
Prerequisites: Basic knowledge in chemistry, biology and geology.

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701-0721-AAL Psychology
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
This is an introductory course in psychology. This course will emphasize cognitive psychology and the psychological experiment.

Objective
Knowledge of key concepts and exemplary theories of psychology and their relation to "daily" psychology. Comprehension of relation between theory and experiment in psychology.

Goals: Learning how psychologists are thinking, a side change from the ETH natural science perspective to psychological thinking.

Domains of psychology:
- Psychology fields
- Concept definitions of psychology
- Theories of psychology
- Methods of psychology
- Results of psychology

Capability:
Be able to define a psychological research question
Basics understanding of role of psychology

Comprehension:
Psychology as a science of experience and behavior of the human

Content
Einführung in die psychologische Forschung und Modellbildung unter besonderer Berücksichtigung der kognitiven Psychologie und des psychologischen Experiments. Themen sind u.a.: Wahrnehmung; Lernen und Entwicklung; Denken und Problemlösen; Kognitive Sozialpsychologie; Risiko und Entscheidung.

Literature
English book of Zimbardo (http://www.amazon.de/Psychology-Life-Discovering-Psych-Lab/dp/0205654770/ref=sr_1_2?s=books-intl-de&ie=UTF8&qid=1317208260&sr=1-2)

Prerequisites / notice
Determine with Prof. Dr. Michael Siegrist the chapters in "Zimbardo" which are compulsory reading

Read the two Psychology chapters (6 + 7) from the book of Prof. Roland W. Scholz

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701-0757-AAL Principles of Economics
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
Students understand basic microeconomics and macroeconomics problems and theories. They are able to argue along economic principles and to judge policy measures.

Objective
Students should be enabled to understand basic microeconomics and macroeconomics problems and theories. They should be able to argue along economic principles and to judge policy measures.

Content
Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomics policies

Lecture notes
available on electronic platform

Literature


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701-1901-AAL Systems Analysis
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
Self study course in Systems Analysis to fulfill requirements for enrollment into the master program. Topics covered include linear box models with one and several variables; non-linear box models with one or several variables; discrete-time models; and continuous models in space and time.

Objective
The aim of this course is to develop an understanding of the dynamical behavior of environmental systems and how this behavior can be captured and understood using mathematical concepts.
Environmental Sciences Master - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>O</td>
<td>Compulsory</td>
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Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>151-0107-20L</td>
<td>High Performance Computing for Science and Engineering (HPCSE I)</td>
<td>W</td>
<td>4 credits</td>
<td>4G</td>
<td>M. Troyer, P. Chatzidoukas</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Introduction to HPC for scientists and engineers</td>
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<td>Fundamental of:</td>
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<tr>
<td></td>
<td>1. Parallel Computing Architectures</td>
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<td>2. MultiCores</td>
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<td>3. ManyCores</td>
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<tr>
<td><strong>Content</strong></td>
<td>Programming models and languages:</td>
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<tr>
<td></td>
<td>1. C++ threading (2 weeks)</td>
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<td>2. OpenMP (4 weeks)</td>
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<td>3. MPI (5 weeks)</td>
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<td></td>
<td>Computers and methods:</td>
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<tr>
<td></td>
<td>1. Hardware and architectures</td>
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<td></td>
<td>2. Libraries</td>
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<td></td>
<td>3. Particles: N-body solvers</td>
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<td></td>
<td>4. Fields: PDEs</td>
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<td></td>
<td>5. Stochastics: Monte Carlo</td>
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</table>

| 151-0213-00L | Fluid Dynamics with the Lattice Boltzmann Method                     | W    | 4 credits | 3G    | I. Karlin                     |
| **Abstract** | The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations. |
| **Objective** | Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations. |
|              | During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on. |
|              | Central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course). |
| **Content**  | The course builds upon three parts:                                   |      |       |       |                               |
|              | I Elementary kinetic theory and lattice Boltzmann simulations introduced on simple examples. |
|              | II Theoretical basis of statistical mechanics and kinetic equations. |      |       |       |                               |
|              | III Lattice Boltzmann method for real-world applications.             |      |       |       |                               |
|              | The content of the course includes:                                  |      |       |       |                               |
|              | 1. Background: Elements of statistical mechanics and kinetic theory: |      |       |       |                               |
|              | Particle's distribution function, Liouville equation, entropy, ensembles; Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation; Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids. |
|              | 2. Basics of the Lattice Boltzmann Method and Simulations:            |      |       |       |                               |
|              | Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures. |
|              | 3. Hands on:                                                         |      |       |       |                               |
|              | Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc); |
|              | 4. Practical issues of LBM for fluid dynamics simulations:           |      |       |       |                               |
|              | Lattice Boltzmann simulations of turbulent flows; numerical stability and accuracy. |
|              | 5. Microflow:                                                        |      |       |       |                               |
|              | Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations. |
|              | 6. Advanced lattice Boltzmann methods:                               |      |       |       |                               |
|              | Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries. |

| 151-0293-00L | Combustion and Reactive Processes in Energy and                      | W    | 4 credits | 2V+1U+2A | K. Boulouchos, F. Ernst       |
| **Abstract** | The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend. |      |       |       |                               |
**Mass Transfer** 4 credits

**Introduction to Plasmonics**

Process design and safety deals with the fundamentals of process apparatus, plant design and safety. The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials. The students should be introduced to the fundamentals of thermal processes on the Bachelor level and recommended as a basis for a future Master in the area of energy. It also includes a dedicated lecture on Master level in Energy Science and Technology and Process Engineering.

**Content**


**Lecture notes**

HANDBOUTS are EXCLUSIVELY IN GERMAN ONLY; however, recommendations for English textbooks will be provided.

**Literature**

TEACHING LANGUAGE IN CLASS is German OR English (ON DEMAND).


151-0911-00L Introduction to Plasmonics W 4 credits 2V+1U D. J. Norris

**Abstract**

This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.

**Objective**

 electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

**Content**

Fundamentals of Plasmonics
- Basic electromagnetic theory
- Properties of metals
- Surface plasmon polaritons on surfaces
- Surface plasmon polariton propagation
- Localized surface plasmons

Applications of Plasmonics
- Waveguides
- Extraordinary optical transmission
- Enhanced spectroscopy
- Sensing
- Metamaterials

**Lecture notes**

Class notes and handouts

**Literature**


**Prerequisites / notice**

Physics I, Physics II

151-0917-00L Mass Transfer W 4 credits 2V+2U R. Büchel, S. E. Pratsinis

**Abstract**

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore, the application of these principles to important engineering problems is demonstrated.

**Objective**

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore, the application of these principles to important engineering problems is demonstrated.

**Content**

Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; application of Fick's laws to diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

**Literature**


**Prerequisites / notice**

Two tests are offered for practicing the course material. Participation is mandatory.

151-0927-00L Rate-Controlled Separations in Fine Chemistry W 4 credits 3G M. Mazzotti

**Abstract**

The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

**Objective**

The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

**Content**

The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

**Lecture notes**

Handouts during the class

**Literature**

Recommendations for text books will be covered in the class

**Prerequisites / notice**

Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

151-0951-00L Process Design and Safety W 4 credits 2V+1U P. Rudolf von Rohr

**Abstract**

Process design and safety deals with the fundamentals of process apparatus, plant design and safety. The goal of the lecture is to expound design characteristics of systems for process engineering applications.
**Content**
Fundamentals of plant and apparatus design; materials in the process industries, mechanical design and design rules of main components; pumps and fans; piping and armatures, safety in process industry

**Lecture notes**
Script is available, English slides will be distributed

**Literature**

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**Practica in Process Engineering I**

**W 2 credits 2P**

P. Rudolf von Rohr, F. Prins

*Prerequisites:* "Einführung in Verfahrenstechnik" (151-0973-00L) and further process engineering courses.

**Abstract**
Practical training at pilot facilities for fundamental processing steps, typical laboratory and pilot facility experiments.

**Objective**
Getting acquainted with unit operations, measuring tools and data processing

**Content**
5 practica in total (3 from Prof. Norris, 2 from Prof. Rudolf von Rohr), details on dates are available at the beginning of the semester in ML H 14 and on our website

- Heat transfer
  - Rudolf von Rohr
- Residence time distribution
  - Rudolf von Rohr
- Thin-film deposition
  - Norris
- Elemental analysis
  - Norris
- Photovoltaics
  - Norris

**Lecture notes**
Descriptions of the practica available

**Literature**
Information in the description

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**Process Simulation and Flowsheeting**

**W 7 credits 3G**

E. Capón García, K. Hungerbühler

**Abstract**
This course encompasses the theoretical principles of chemical process simulation, as well as its practical application in process analysis and optimization. The techniques for simulating stationary and dynamic processes are presented, and illustrated with case studies. Commercial software packages are presented as a key engineering tool for solving process flowsheeting and simulation problems.

**Objective**
This course aims to develop the competency of chemical engineers in process flowsheeting and simulation. Specifically, students will develop the following skills:
- Deep understanding of chemical engineering fundamentals: the acquisition of new concepts and the application of previous knowledge in the area of chemical process systems and their mechanisms are crucial to intelligently simulate and evaluate processes.
- Modeling of general chemical processes and systems: students have to be able to identify the boundaries of the system to be studied and develop the set of relevant mathematical relations, which describe the process behavior.
- Mathematical reasoning and computational skills: the familiarization with mathematical algorithms and computational tools is essential to be capable of achieving rapid and reliable solutions to simulation and optimization problems. Hence, students will learn the mathematical principles necessary for process simulation and optimization, as well as the structure and application of process simulation software. Thus, they will be able develop criteria to correctly use commercial software packages and critically evaluate their results.

**Content**
Overview of process simulation and flowsheeting
- Definition and fundamentals
- Classification: stationary (steady-state) versus dynamic (transient state) systems
- Fields of application
- Case studies

Process modeling
- Modeling strategies of process systems
- Mass conservation
- Species balance
- Energy conservation
- Momentum balance
- Multiphase-systems: equilibrium & non-equilibrium models
- Process system model

Process simulation
- Process specification
- Introduction to process specification
- Classification of mathematical models: AMS, DOE, DAE, PDE
- Model validation
- Software tools
- Solution methods for process flowsheeting
- Simultaneous methods
- Sequential methods
- Dynamic simulation
- Numerical solution: explicit and implicit methods
- Continuous-discrete simulation: handling of discontinuities

Process optimization and analysis
- Classification of optimization problems
- Linear programming
- Non-linear programming
- Dynamic programming
- Optimization methods in process flowsheeting
- Sequential methods
- Simultaneous methods

Commercial software for simulation: Aspen Plus
- Thermodynamic property methods
- Reaction and reactors
- Separation / columns
- Convergence & debugging
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling,

3 credits 4 credits

Understanding acoustophoresis, the design of devices and potential applications

Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process

Topics that will be covered include: Uncertainty quantification under

Handouts during course

Radiation Heat Transfer

Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a

Introduction  membrane operations  adsorption and chromatography   crystallization  overall process economics

Economy

Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a

Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process

Content

Lecture notes

Handouts during course

Radiation Heat Transfer

Advanced course in radiation heat transfer

Fundamentals of radiative heat transfer and its applications. Examples are combustion and solar thermal/thermochemical processes, and

Objective


Enclosure theory- radiosity method. Monte Carlo.


Equation of radiative transfer. Solution methods: discrete ordinate; zone; Monte-Carlo.


transfer.

Lecture notes

Copy of the slides presented.

Literature


Uncertainty Quantification for Engineering & Life Sciences

Number of participants limited to 60.

Objective

The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in

Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of

relevant algorithms in multicore architectures.

Content

Topics that will be covered include: Uncertainty quantification under

parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo

simulation, prior and posterior reliability analysis.

Lecture notes

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related

literature that will be distributed in class.

Literature

1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia

2. Probability Theory: The Logic of Science by E. T. Jaynes

3. Class Notes

Prerequisites / notice

Fundamentals of Probability, Fundamentals of Computational Modeling

Microscale Acoustofluidics

Number of participants limited to 30.

Abstract

In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid

mechanics perspective with applications to microsystems and lab on a chip devices.

Objective

Understanding acoustophoresis, the design of devices and potential applications

Content

Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling,

acoustic streaming, applications from ultrasonic microtubotics to surface acoustic wave devices

Lecture notes


Prerequisites / notice

Solid and fluid continuum mechanics. Notice: the exercise part is a mixture of presentation, lab session and hand in homework.

Multidisciplinary Courses

The students are free to choose individually from the entire course offer of ETH Zurich, ETH Lausanne and the Universities of Zurich and St. Gallen.

Course Catalogue of ETH Zurich

Semester Project

Number Title Type ECTS Hours Lecturers

3 credits 4 credits

Semester Project Process Engineering

Only for Process Engineering MSc.

The subject of the Master Thesis and the choice of the

Data: 06.11.2018 12:57 Autumn Semester 2016 Page 1569 of 1571
supervisor (ETH-professor) are to be approved in advance by the tutor.

**Abstract**

The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

**Objective**

The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program.

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**Industrial Internship**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-1012-00L</td>
<td>Industrial Internship Process Engineering</td>
<td>O</td>
<td>8 credits</td>
<td></td>
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</table>

**Abstract**

The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

**Objective**

The main objective of the 12-week internship is to expose master's students to the industrial work environment.

---

**GESS Science in Perspective**

Recommended GESS Science in Perspective (Type B) for D-MAVT.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

---

**Master's Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-1005-00L</td>
<td>Master's Thesis Process Engineering</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
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</tbody>
</table>

Students who fulfill the following criteria are allowed to begin with their Master's Thesis:

a. successful completion of the bachelor program;
b. fulfilling of any additional requirements necessary to gain admission to the master programme;
c. successful completion of the semester project and industrial internship;
d. achievement of 28 ECTS in the category "Core Courses".

The Master's Thesis must be approved in advance by the tutor and is supervised by a professor of ETH Zurich. To choose a titular professor as a supervisor, please contact the D-MAVT Student Administration.

**Abstract**

Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

**Objective**

The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

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**Seminars, Colloquia, and Additional Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>151-0931-00L</td>
<td>Seminar on Particle Technology</td>
<td>E-</td>
<td>0 credits</td>
<td>3S</td>
<td>S. E. Pratsinis</td>
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</table>

The goal of the lecture is to convey a basic knowledge in the area of FV materials as well as their construction and production processes and to empower the students to apply the knowledge gained to address current problems in research and practice.

**Abstract**

Students attend and give research presentations for the research they plan to do and at the end of the semester they defend their results and answer questions from research scientists. Familiarize the students with the latest in this field.

**Objective**

Research seminar for master's students and doctoral students

**227-0902-00L**

**Seminar in Systems and Control**

**Abstract**

Current topics in Systems and Control presented mostly by external speakers from academia and industry

see above

**Objective**

Research seminar for master's students and doctoral students

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**227-0950-00L**

**Acoustics**

**Abstract**

Current topics in Acoustics presented mostly by external speakers from academia and industry.

see above

**Objective**

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**227-0970-00L**

**Research Topics in Biomedical Engineering**

**Abstract**

Current topics in Biomedical Engineering presented by speakers from academia and industry.

Getting insight into actual areas and problems of Biomedical Engineering an Health Care.

**Objective**

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**Process Engineering Master - Key for Type**

<table>
<thead>
<tr>
<th>O</th>
<th>W+</th>
<th>W</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
<th>Z</th>
<th>Courses outside the curriculum</th>
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<tbody>
<tr>
<td></td>
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<td></td>
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<td>Dr</td>
<td>Suitable for doctorate</td>
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<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.